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The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

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The New Weakness of the Individualist

The average British manufacturer is no more enamoured of large combines, integrated employers' federations and inter-industrial agreements than he is of political interference on the Continent of Europe, but matters abroad move so rapidly that combines appear to be essential for the protection of United Kingdom interests. Just as the country found it expedient to adopt a system of protection of the home market, the second natural step is apparently the creation of employers' federations well capable of speaking for the industry they represent as a national voice. Quite recently an announcement came from Germany telling of the virtual nationalisation of the iron and steel industry. Already Japan, Italy and, to a lesser extent, France are so organised that the Governments of these countries speak in the name of their various industries or *vice versa*. When the industries speak, it is but the echo of the policy of the country in which they are located. It is admittedly not easy for a country to know the difficulties and aspirations of an industry unless it be well organised, and it is significant that in recent years employers' federations have been regarded as mouthpieces rather than as enemies of the State. This new aspect carries with it obligations of considerable magnitude, and whilst suppression is no longer hinted at, proposals are extant that independent committees should be created to hold a watching brief for the general public. The various foundry owners of this country are awaiting with considerable interest just how the regularly constituted federations are going to act in order to bring the organisation of their industry in line with foreign endeavour and meet on level terms their suppliers and consumers. It is a *sine qua non* that the most opportune time for organising United Kingdom business men into a federation is during periods of good trade, and not during slumps, when feeling, due to excessive competition, runs too high. Thus, if it is felt essential or even desirable that the time has arrived when the foundry industry should participate in such matters as the international movement of scrap, or assume a voice in the equitable distribution of other raw materials, there can be no more favourable moment than the present time. The existing communities of interest will evaporate into thin air with a downward trend of the industrial barometer, leaving only that of insensate competition as a common bond. It is our experience that this last factor forms the poorest basis for enthusiastic membership of a federation, for it is born of mutual suspicion. Whilst trade is good, strenuous efforts should be made to re-enforce membership or else await the next boom for action, in order to create a team worthy of placing in the field against governmentally controlled industries of other countries.

Pulverised Coal Risks

The foundry industry is and has for some years been using pulverised coal, not only for rotary but for other types of furnaces. The risk arising from its use, on account of its explosive character under certain conditions, is well known, and the Home Office has issued as Form 831 a schedule of precautions to be observed in the construction, working and repair of coal-drying and pulverising plants. As makers and users of such plants have been consulted we may take it that the schedule represents a substantial measure of agreement.

The two systems, one involving unit plants and the other central pulverising and central storage, are well known. The regulations apply to the latter and only to the former when of greater capacity than 30 cwt. per hr. per unit. The main object of the proposals is to prevent the leakage and escape of dust, and the lodging and accumulation of dust where it will remain stationary. All parts of the system are required to be so designed, constructed and maintained as to prevent dust escaping, or to prevent it settling and lodging in internal lodges or pockets. Relief doors are required on chambers or casings, except on pipes, ducts, or mills able to withstand a pressure of 15 lbs. per sq. in., and should be so constructed that after being blown open they close automatically. The remaining provisions refer to means of escape, and instruction to staff respecting fire-drill and fire extinction. The use of naked lights, welding plant and so on is prohibited except when pulverising plant is out of service, and smoking should be prohibited. Attention is drawn to the legal requirements in respect of electrical plant in inflammable surroundings. All those directly interested in the manufacture, transport or use of pulverised fuel will wish to acquaint themselves directly with the provisions of this circular if they are not already familiar with it, while those who contemplate using it will gain from the above brief outline some idea of the precautions to be taken in using a substance which may under certain circumstances become explosive. The possibility of spontaneous combustion is one also well borne in mind by foundries storing coal dust in the neighbourhood of heat.

American Society for Testing Materials

ELECTION OF OFFICERS

At the fortieth annual meeting of the American Society for Testing Materials, held in New York City, Mr. A. E. White, Professor of metallurgical engineering, and director, department of engineering research, University of Michigan, Ann Arbor, Mich., was elected President for the ensuing year. Mr. H. H. Morgan, manager, Rail and Track Fastenings Department, Robert W. Hunt Company, Chicago, Ill., was elected Vice-President, his term of office lasting two years. Members who were elected to the executive committee are as follow:—Mr. P. H. Bates, chief, Clay and Silicate Products Division, National Bureau of Standards, Washington, D.C.; Mr. H. F. Clemmer, engineer of materials, District of Columbia, Washington, D.C.; Dr. G. E. F. Lundell, assistant chief, Chemistry Division, National Bureau of Standards, Washington, D.C.; Mr. H. C. Mougey, chief chemist and assistant technical director, Research Laboratories Division, General Motors Corporation, Detroit, Mich.; and Mr. R. L. Templin, chief engineer of tests, Aluminum Company of America, New Kensington, Pa.

The Dudley Medal

Mr. W. H. Swanger, chief, section of mechanical metallurgy, and assistant chief, division of metallurgy, and Mr. G. F. Wohlgemuth, associate metallurgist, National Bureau of Standards, were presented with the Charles B. Dudley Medal of the Society for 1937. This medal commemorates the name of the first A.S.T.M. President, and is awarded to the author or authors of the Paper presented at the preceding annual meeting which is of outstanding merit and constitutes an original contribution on research in engineering materials. This Paper was entitled "Failure of Heat-Treated Steel Wire in Cables of the Mt. Hope, R.I., Suspension Bridge."

Combustion Appliance Makers' Association

The Combustion Appliance Makers' Association (Solid Fuel) recently published the Proceedings of its First Annual Conference. The Proceedings includes three Papers, "The Progress of Solid Fuel Burning Appliances," and a discussion. The first Paper deals with applied combustion research, and the authors emphasise the importance of combustion as compared with any other form of utilisation of coal. Figures show that of 180 million tons of coal consumed annually in Great Britain, some 167 million are burned in solid form. To bring applied research in the utilisation of coal level with that conducted by the great oil companies in the utilisation of oil, the authors point out that a sum of £500,000 a year would have to be spent, and that this amounts to ½d. a ton on the coal raised annually.

The second part of the Paper, dealing with the domestic market for solid fuel, provoked a valuable discussion, including a contribution from Dr. Sinnatt, the Director of Fuel Research. The authors and the various speakers were in general agreement that a natural equilibrium existed between coal, gas and electricity as domestic heating and cooking agents, and that any attempt to gain a monopoly for one of these to the exclusion of the others would only result in injury to the coal industry and increased costs to the domestic consumer.

The third Paper, dealing with progress of mechanical firing, gives an unbiassed statement of recent advances. An interesting feature of this section, and the discussion on it, was the general agreement that progress in the future might take the form of reduction in capital and maintenance costs rather than increase in efficiency.

Foundry Workers and Paid Holidays

Metallurgical works which have voluntarily conceded holidays with pay were referred to at the last sitting of the special Government Committee inquiry on Holidays with Pay at the Ministry of Labour, Whitehall, S.W.1, presided over by Lord Amulree.

It was intimated that the Ministry had cognizance of individual arrangements with their employees by a number of firms.

The Trade Union Congress, through its general secretary, Sir Walter Citrine, claimed a paid holiday of 12 days, excluding all bank and public holidays, after twelve months service, and of one day for every completed month of service of less than twelve months, the holiday to be taken in an unbroken period, if practicable, and preferably between the months of April and October. He suggested that the holiday pay was to be the customary hourly or weekly time rate provided for the particular grade by collective agreement in the industry concerned, and the entering into any alternate paid employment during the holiday period to disqualify the person from receiving the holiday pay. Sir Walter contended that the paid holiday might put up to 4 per cent. on the country's annual wage bill, British industry could well afford it, and the benefit would no doubt be well reflected in higher output and increased efficiency. Sir Walter was opposed to all voluntary schemes on principle, and wanted nothing short of legal enactment, leaving the application through joint industrial bodies as elastic as possible. The Committee is now hearing evidence from individual industries, either objecting *in toto* or desiring special treatment.

Impeller Corrosion

According to "Monel Notes" many corrosion problems, caused by impure water, have been satisfactorily solved by the use of Monel castings. Such a problem occurred in an oil company where trouble was encountered with the impeller in a turbine feed pump. When originally supplied by the makers this particular pump was fitted with a gunmetal impeller. From the first, considerable difficulty was experienced owing to corrosion and efforts were made to eliminate the trouble by the use of a special gunmetal and subsequently by installing a cast Monel impeller.

The service obtained from the gunmetal impellers was as follows:—

Original impeller, 29 weeks.
Spare impeller, 32½ weeks.
Special quality impeller, 34 weeks.

During the above periods of service the pump was worked continuously, night and day, and in every case before renewals were made the pump had dropped considerably in efficiency.

The Monel impeller was then installed, and after a year's service the pump was dismantled for examination and the engineers' report was as follows:—

"On examination of the impeller we find that there is no perceptible wear, and that the surface of the metal is still smooth and bright, but the phosphor-bronze packing rings show a wear to the extent of 41/1000 of an inch. The Monel impeller appears to be standing up to the work in this pump very satisfactorily and is a vast improvement on the life of the original gunmetal impellers which only gave us about seven months' work."

Three years later the Monel impeller was once more examined and "no trace of wear or corrosion was found." A year later this impeller was "touched up and again put into service." At this date over four years' service had been obtained with the impeller still operating satisfactorily.

AMONGST SHIPMENTS of ore and pig-iron due at Glasgow this week are 7,500 tons of pig-iron from Canada. This is a new source of supply.

Random Shots

The autumn meeting of the Institute of Metals looks very interesting, for, apart from being staged in Sheffield, itself an attraction to men of metals, there is to be a party got together to dine and cabaret at the Grand Hotel, at which the men are specially instructed to limit the number of their ladies to 80! Has Sheffield become a sort of English Utah? There is, of course, the inevitable, but none the less enjoyable, visit to Derbyshire—Sheffielders show their business visitors hastily round Brightside and allow them to linger in Derbyshire—their Brighterside. In Derbyshire they can only pick up heather. In Brightside—well, you never know what they can pick up!

* * *

Whilst Germany has over 100 students attending foundry schools, England has only five. What is the youth of England thinking of? Men who have in their younger days served a period of time as steel melters usually were very lyrical about the job, and it is quite obvious, to hear them talk, that a man is not a real man unless he can pitch a shovelful of dolomite to within an inch. Maybe it is all the fault of these milk-bars!

* * *

The inaugurators of the scrap iron campaign must go one step further. Many people, having taken "Marksman's" advice to spend the holiday week-end in attic and outhouse, are now crying out, "Who is going to collect the scrap we have found?"

* * *

One friend remembered an interoven stored under the kitchen floor in desperation some years ago. Another found a few bits of an Ideal boiler that had been replaced three years previously. "Marksman" himself found the following assortment: A sample ingot of tin, given at a "Tin" luncheon, a model of a flexible coupling, made by Wellman Bibby & Company, a notepaper die bearing a former telephone number, and, lastly, a piece of "bad-steelmaker's friend." Now, who is going to collect it all? It seems to be a question for co-operation between the scrap iron merchants and the civic authorities' highways and cleansing departments.

* * *

Apparently Father still comes home and shows his authority by hitting Ma on the head with the poker, whilst Ma retaliates with the frying pan, for there are still more accidents in the home than there are in industry. Yet it may be the modern house is to blame. Being so small as to preclude any indulgence in the old-time practice of "swinging the cat round"—the cat remains on the floor—and mother falls over the said cat with a kettle of boiling water in her hand. The cat miaows loudly and goes hell-for-leather down the garden path, where Father is busy with hoe. Tripping over the cat, he hoes off his big toe, and in his rage throws the darn thing at Junior, who is helping close at hand. And so all the family is hurt, and no Factory Act in the world can stop such tragedies of 'uman nature in the 'appy 'ome.

* * *

As if metallurgists had not sufficient to do at the moment inventing alloys light enough to chase through the ether at ridiculous speeds, non-corrosive enough to propel leviathan ships safely across the seven seas, and sharp enough to cut the whiskers off hairy man, they have had to busy themselves creating metals that will resist all the wiles and crafty measures known to the burglars of safes. Safes now need to be not only undrillable, but explosion-proof and fireproof. The future burglar will have to be, not a man of low cunning, but a high-grade metallurgist, and will not get a job without a University degree.

"MARKSMAN."

British Foundry School

SECOND ANNUAL REPORT

Introduction

In presenting their second annual report and statement of accounts of the British Foundry School, the governing body point out that the second financial year ended on March 31, 1937, so that the statement of accounts includes all receipts and expenditure to that date. As far as the progress of the School is concerned, the present report extends to the end of the second session, July 24, 1937.

The first report indicated the origin of the School, the scope of the industry it is intended to serve, and the formation of a provisional committee and subsequently of a provisional governing body from a group of ten research associations, technical institutions and trade associations in the industry, which offered financial support to the School. These institutions have continued their support, and the list of them is as follows:—British Cast Iron Research Association; British Non-Ferrous Metals Research Association; City and Guilds of London Institute; Institute of British Foundrymen; Institution of Automobile Engineers; Institution of Mechanical Engineers; Iron and Steel Industrial Research Council of the British Iron and Steel Federation; Iron and Steel Institute; the National Light Castings Ironfounders' Federation; and the Welsh Engineers' and Founders' Association.

Annual Meeting

The first annual meeting of the School was held in Birmingham on July 21, 1936, Mr. R. G. Hosking, chairman of the governing body, presiding. The chairman presented the annual report and statement of accounts, which had been circulated, and outlined the progress made during the year. The report and accounts were unanimously adopted. The governing body were unanimously re-elected, and Bendall, Denson & Company were unanimously elected auditors for the ensuing year.

Officers

Mr. R. G. Hosking was unanimously re-elected chairman, and Alderman W. Byng Kenrick, vice-chairman of the governing body. Mr. J. G. Pearce was also re-elected hon. adviser and hon. treasurer. The chairman, hon. adviser, Dr. D. S. Anderson, Dr. F. T. Chapman, Mr. John Ellis, Mr. R. W. Blount, and Mr. G. L. Bailey were formally elected by the governors to form an executive committee, and this committee has had four meetings. Three meetings of the governing body have been held.

Finance

The statement of accounts for the year shows a total income of £1,454 11s., and an excess of income over expenditure of £97 4s. 4d. The expenditure is materially in excess of that for the first year, £866, because the first year's accounts represented six months' expenditure only, from September, 1935, to March, 1936, and the figure for the year under review is for the first year involving a complete normal annual expenditure. The drop in the number of students for the second year reduced the income from students' fees, and there is a reduction in donations and subscriptions, due in part to the fact that this item appearing on the first balance sheet was collected over a longer period than one year. The governing body appeal to firms and interested persons to assist in maintaining the figure from industrial sources at £500 per annum, which is only one-third of the total school expenditure. The income of the School from industrial sources is derived in part from the institutions founding the School, referred to above, and in part from donations and subscriptions from interested firms and persons. The ten institutions provide an annual income of about £200, so that £300 only is required in the form of direct industrial contributions.

The income from industrial firms is given below for the year 1936 to 1937.

	£	s.	d.
Bristol Aeroplane Company, Limited, Bristol	2	2	0
A. Reyrolle & Company, Limited, Hebburn-on-Tyne	5	5	0
Babcock & Wilcox, Limited, Renfrew	25	0	0
Manganese Bronze & Brass Company, Limited, London	3	3	0
Newton, Chambers & Company, Limited, Sheffield	5	0	0
Blakey's Boot Protectors, Limited, Leeds	10	10	0
Northern Aluminium Company, Limited, London	10	10	0
F. A. Hughes & Company, Limited, London	3	3	0
Belliss & Morcom, Limited, Birmingham	10	10	0
Vickers-Armstrong, Limited, Barrow-in-Furness	5	5	0
Birmingham Aluminium Casting (1903) Company, Limited	10	10	0
Sir W. H. Bailey & Company, Limited, Salford	3	3	0
Hopkinsons, Limited, Huddersfield	10	10	0
J. Samuel White & Company, Limited, Cowes, I.O.W.	1	1	0
Austin Motor Company, Limited, Birmingham	10	10	0
Imperial Chemical Industries, Limited, London	20	0	0
L. Gardner & Sons, Limited, Manchester	10	10	0
H. W. Ward & Company, Limited, Birmingham	2	2	0
Winget, Limited, Rochester	5	5	0
S. Russell & Sons, Limited, Leicester	10	0	0
James Archdale & Company, Limited, Birmingham	2	2	0
Markham & Company, Limited, Chesterfield	2	2	0
English Electric Company, Limited, Stafford	5	5	0
Laurence, Scott & Electromotors, Limited, Norwich	3	3	0
Ley's Malleable Castings Company, Limited, Derby	10	10	0
Stanton Ironworks Company, Limited, Nottingham	25	0	0
Sir W. G. Armstrong Whitworth & Company, Limited, Gateshead-upon-Tyne	15	15	0
	£227	16	0

Since the end of the year a contribution of £5 5s. has been received from W. & T. Avery, Limited, Birmingham.

The governing body desire to express their grateful thanks for support from institutions and firms, and look forward to its continuation in the future.

Students.—Four students, nominated by the Northern Aluminium Company, the L.M.S. Railway and the Eclipse Tube Mill Liners of Boston, U.S.A., enrolled for the second session. The governing body also approved of Mr. C. A. Timms, who had been appointed demonstrator to the School, taking the course during the session. The Foundry Technical Group has been formed for the purpose of maintaining social and professional contacts between present and past students.

Staff.—Mr. J. Bamford, B.Sc., is lecturer-in-charge of the School, and Mr. C. A. Timms has acted as demonstrator. The lecture and laboratory work in metallurgical analysis has been taken by Mr. W. E. Thorneycroft, B.Sc., and in pyrometry by Mr. A. A. Timmins, A.I.C.

Curriculum.—The curriculum of the School for the year is outlined at the end of this report.

As in the first year, attendance is required from each student for over thirty-nine hours per week for a period of about forty weeks, and students are required to do a considerable amount of work in their own time. It is desired to emphasise that no practical training in the ordinary sense of the term is given, since practical training in a foundry is an essential requirement for entry to the course. Three special features of the course, however, illustrate the intensely practical way in which the whole subject is dealt with. The first involves the conduct by the student of a series of practical studies, of two kinds: moulding and casting studies and foundry planning. In the former the student is expected to prepare from a given casting or blue print a complete scheme of foundry production, including composition, melting equipment and charges, weight of the casting, machining allowances, construction of pattern and core boxes, methods of moulding and details of sand and its treatment, methods of gating and running, and methods of pouring, together with the man-hours required for manufacture, with the cost. On foundry planning the student is expected to design a foundry or to re-model an existing foundry to specified requirements. A large number of studies of this kind are made during the year, and two-thirds of the time of the diploma examination is devoted to dealing with two tasks of this character.

The second feature of the course to which special attention is drawn is the employment of specialised lecturers dealing with subjects of which they have special knowledge. Over one hundred lectures were given during the session, by over sixty specialists. The governing body desire to thank these associate lecturers for providing this group of lectures, which are all followed by discussions in which students take part. In a number of cases associate lecturers have kindly allowed their fees to be returned to the School funds, and this is greatly appreciated by the governors.

Works Visits

The third feature of the course is the large number of visits paid to foundries. The governors desire to express their very grateful thanks to foundries who have so kindly permitted students to make these visits, and in a number of cases for the hospitality they have provided. The list of the works visited is as follows:—Higgs Motors, Limited, Witton; British Piston Ring Company, Limited, Coventry; S. Flavel & Company, Limited, Leamington; Morris Motors, Limited, Coventry; London Midland & Scottish Railway Company's Foundries, Derby; International Combustion, Limited, Derby; Sterling Metals, Limited, Coventry; Taylor & Farley, Limited, West Bromwich; John Harper & Company, Limited, Willenhall; Alfred Herbert, Limited, Coventry; Ley's Malleable Castings Company, Limited, Derby; W. & T. Avery, Limited, Smethwick; F. H. Lloyd & Company, Limited, Darlaston; Daimler Company, Limited, Coventry; G. & R. Thomas, Limited, Walsall; Qualcast, Limited, Derby; Ferranti, Limited, Manchester; Austin Motor Company, Limited, Northfield; British Industries Fair, Castle Bromwich; Bridge Foundry Company, Limited, Wednesbury; Birmingham Aluminium Company, Limited, Smethwick; S. Russell & Sons, Limited, Leicester; Audley Engineering Company, Limited, Newport, Shropshire; Birmingham Electric Furnaces, Limited, Birmingham; Midland Motor Cylinder Company, Limited, Smethwick; Metropolitan-Vickers Electrical Company, Limited, Manchester; English Steel Corporation, Limited, Sheffield; Leyland Motors, Limited, Leyland; British Thomson-Houston Company, Limited, Rugby; London & North Eastern Railway Company's Foundries, Gorton; Sheepbridge Stokes Centrifugal Castings Company, Limited, Chesterfield; Platt Bros., Limited, Oldham; Stanton Ironworks Company, Limited, Stanton; Rolls-Royce, Limited, Derby; David Brown & Sons (Hudd.), Limited, Huddersfield; Midland Electric Manufacturing Company, Limited, Birmingham; and William Mills, Limited, Smethwick.

Towards the end of the first session a highly successful visit was paid to Scotland, where ten

plants were visited. During the session under review, the annual visit was paid to London and the South, where ten visits were also made, as follows:—Great Western Railway Company's Foundries, Swindon; Dewrance & Company, London; British Bath Company, Limited, Greenford; British Non-Ferrous Metals Research Association's Laboratories, London; Kryn & Lahy (1928), Limited, Letchworth; Ford Motors, Limited, Dagenham; Southern Railway Company's Foundries, Eastleigh; J. Stone & Company, Limited, Charlton; Winget, Limited, Rochester; and H.M. Dockyard, Chatham.

Diploma Examination

The diploma examination consisted of four subjects, as follows:—Foundry metallurgy (two papers), foundry technology, foundry management, and moulding and casting studies and foundry projects. The written Papers (metallurgy, technology, management) are each of three hours' duration. For the ferrous study and/or project (cast iron or cast steel) twelve hours are allowed, and for the non-ferrous study and/or project, nine hours. The Papers set at the diploma examination will be available to those interested.

On the results of the Diploma examination at the end of the first session, 13 awards were made. No division into classes is made, but students obtaining 85 per cent. of the possible marks in any of the four subjects of the examination are awarded distinction. The governing body are indebted to the Principal of the Birmingham Central School of Art for assistance in the design of a suitable diploma, which carries the Seal of the Board of Education.

The following authorities have acted as assessors in the preparation and marking of the papers:—

Foundry Metallurgy.—Principal C. A. Edwards, D.Sc., F.R.S. (Principal and Professor of Metallurgy, University College, Swansea).

Foundry Management and Foundry Technology.—Mr. E. R. Briggs, M.Inst.C.E., M.I.Mech.E. (Rugby).

Cast Iron Moulding and Casting Study and Project.—Mr. F. J. Cook, M.I.Mech.E. (Birmingham).

Steel Moulding and Casting Study and Project.—Dr. C. J. Dadswell (Sheffield).

Non-Ferrous Moulding and Casting Study and Project.—Mr. J. A. Clavey (Manchester).

Foreign Foundry Schools

During the year the hon. adviser visited the Engineering and Foundry School at Duisburg, which has been in existence for fifty-five years, and which prepares students of the foreman grade for the foundry industry. The course lasts approximately two and a-half years, and the number of students for the foundry industry in the school at any one time is about eighty. The French Foundry School at Paris has undergone a material change in organisation during the year, following the retirement of its founder and first director, Mr. E. Ronceray. Prof. A. Portevin has been appointed director, and Mr. R. Lemoine, assistant director.

Acknowledgments

The governing body desire to express their great appreciation of the valuable assistance the School has received from Dr. D. S. Anderson, Principal, and Dr. F. Johnson, director of metallurgy at the Birmingham Central Technical College, in which the School is housed. They are also greatly indebted to Mr. John Belliss for unremitting help.

Conclusion

The governors recognise that the number of students in the School at any time is likely to be small, and at present do not seek more than ten or twelve students. They view with some concern the fall during the second session compared with the thirteen registering for the first session, a greater number than was anticipated. It is impossible to expect the Board of Education, which provides such generous grant aid to the School, to continue unless the number of students really shows that there is an industrial demand, and it is therefore urged that all those responsible for the conduct of foundry operations, directly or indirectly, should consider whether the School can aid them in building up a suitable personnel. Evidences have not been lacking that in some foundries the School would be regarded as an integral part of the training of foundrymen for responsible posts, and it is hoped that this will become more widespread. Where such young men have first to be selected and provided with suitable practical training, entry to the School will inevitably be delayed. There is little doubt that the great pressure on foundry establishments during the past year has made it very difficult for firms to release suitable men, but it is hoped that this will not continue, because it is easier to contemplate arrangements of this kind when industry is in a comparatively prosperous state.

CURRICULUM

Below we detail the studies followed at the School:—

The Founding Industry.—The founding of steel, cast iron, malleable cast iron and non-ferrous metals in Great Britain and abroad. The sections of the industry. Their relations to other branches of the engineering and of the iron and steel industries. Types of foundries. Detached and dependent foundries. Specialised and jobbing foundries. The internal structure of the industry. Technical and scientific institutions, research associations, trade associations. Grades of people employed in the industry and their functions. Methods of training and courses of instruction for apprentices, operatives, technical workers.

Foundry Organisation and Planning.—The location and planning of foundries. Foundries in relation to raw material supplies, markets, labour and transport. Modern tendencies in continuous and mass production. Purchase of raw materials. The use of specifications in buying and selling. Selling problems and markets. Internal organisation and planning. Equipment and supplies. Costing.

Raw Materials.—Pig-irons. Charcoal irons. Hot and cold blast pig irons. Refined irons. Fracture and analysis. Ferro alloys. Steel scrap. Cast-iron scrap. Non-ferrous metals and alloys. Fluxes. Moulding and core sands. Natural sands. Synthetic sands. Mixtures for light and heavy work. Repetition and jobbing work. Sand treatment in a mechanised plant. The effect of moisture, milling and ramming on sands. Properties affecting their use in the foundry. Grain size, refractoriness, strength, permeability. Use of coal dust and facings. Control of sands. Sand testing. Sand problems in relation to continuous production. Green sand, dry sand and loam working. The chemistry of oil sand cores and core binders. Refractory materials for the foundry. Metallurgical coke. Coal, oil, pulverised fuel, gas and electricity as fuel for melting, annealing and other furnaces.

Processes and Equipment.—The foundry cupola. History and development. Melting losses. Oxidation losses. Carbon pick-up. Sulphur pick-up. Fluxes. Slags. Desulphurisation. Deoxidation. Receiver and non-receiver cupolas. Blowers and fans. Measurement of molten metal temperatures. Ferro-alloy additions. Mechanical charging. The crucible furnace for ferrous and non-ferrous melting. The air furnace. The rotary pulverised fuel and oil-fired furnaces. The electric induction furnace. Arc furnaces. The converter. The open-hearth furnace. Foundry pyrometry. The tools of the moulder, core maker and patternmaker. Moulding and coremaking practice. Patternmaking. Moulding machines. The after-treatment of cast iron. Annealing. Heat-treatment. Fettling. Finishing processes. Sand-blasting, pickling, enamelling, galvanising, plating.

Chemistry.—General principles of chemistry. Physical and chemical change. Mixtures and compounds. Atoms and molecules. Symbols, formulæ, equations. Air, its composition and impurities. General properties of gases. Gaseous diffusion. Nitrogen. Oxygen. Nature of oxides. Oxidation. Reduction. Corrosion. Water. Solution. Composition of water. Hydrogen. Metals and non-metals. Acids, bases and salts. Laws of chemical combination. Equivalents. Iron and its oxides. Carbon and its oxides. Producer gas; water gas; coal and coal gas. General principles of combustion. Iron and the common metals and non-metals and their metallurgically important compounds. Elementary chemistry of fluxes, slags, refractories, sands, fuels (solid, liquid, gaseous), cements. Limestone, felspar and other fluxes. Silica, glass. Slag and refractory compositions. Coke, coal and pulverised coal. Fuel oil. The elementary chemistry of drying oils.

Metallurgy.—Properties of metals and alloys. Melting points—behaviour during solidification: Expansion, contraction, structure, inclusions, etc. Ores: Extraction, fluxes, refractories. Electrolytic processes. Types of furnace and working conditions. Solid, liquid and gaseous fuels: Calorific values, etc. Iron: Pig-iron, cast iron, wrought iron, steel. Effect of impurities. Cast iron and steel for special purposes, nickel chromium, etc. Iron and carbon, pearlite, ferrite, martensite, austenite, graphite and its formations. Iron carbon silicon, iron carbon manganese, iron carbon phosphorus, iron carbon sulphur. Influence of nickel, chromium, copper, aluminium, titanium, vanadium, molybdenum, tungsten, cobalt. Metallurgy of copper, zinc, tin, lead, nickel, aluminium and their alloys; bronzes, brasses, aluminium alloys, bearing metals, etc. Effects of alloying, influence on melting point. Behaviour during solidification. Methods of preparing alloys.

Mechanical Engineering.—Stress, strain, Young's modulus, Hooke's law. Elastic properties of materials. Tenacity and ductility. Methods of determining ultimate strength of materials in tension and compression. Effect of composition and heat-treatment on results. Yield point, elastic limit, maximum load, hardness, tests for hardness. Impact test. Fatigue of metal. Beam theory. Transverse tests. Recommendations of B.S.I. on size of test-pieces.

Electrical Engineering.—Units. Magnetic and non-magnetic materials. Magnetisation of iron and steel, permeability, flux, magnetic circuit. Electro-magnets. D.C. motor and generator. Electric and magnetic circuits. Types in use in foundries, fettling machines, large motors for sand mills, blowers, etc. Efficiency. A.C. machines. Types in foundries, high-cycle hand grinders. Fans, blowers, etc. Power factory. Efficiency. Properties required in castings for electrical machines, *i.e*, magnetic frames, brush holders, resistance grids, etc.

Foundry Metallurgy.—The metallurgy of cast iron and cast steel. Pure irons, iron-carbon alloys. The iron-carbon diagram. The phase rule. Structural components. The influence of elements present and of alloy additions. Malleable cast iron, austenitic irons and steels. The influence of gases. Fluidity. Chill. Defects. Shrinkage and contraction. Physical properties. Mechanical properties at ordinary and elevated temperatures. Resistance to heat. Resistance to corrosion. Resistance to wear. Standard tests, British and foreign. Relationship of size of test-piece to size of casting. High-duty irons and steels. The metallurgy of the non-ferrous metals. Composition, structure and properties at ordinary and elevated temperatures of the alloys of copper, tin, zinc, aluminium, nickel, magnesium. Brasses, bronzes, light alloys.

Laboratory Work

Laboratory work includes the following:

Metallographical Laboratory.—The preparation and polishing of samples for examination of unetched and etched structures. Micro and macro structures. The interpretation of photomicrographs. Components of structure in ferrous and non-ferrous castings. The study of inclusions. Porosity and openness.

Chemical Laboratory.—The preparation of samples of cast ferrous and non-ferrous metals for chemical analysis and the qualitative and quantitative determination of elements present. The calculation of compounds actually present. The examination of foundry blackings, facings, fuels, sands, refractories, slags.

Sands and Refractories Laboratory.—Moulding and core sands and foundry refractories. Standard tests on moulding sands, core sands, coal-dusts, blackings and facings. Tests on green sand, dry sand and loam. Oil-sand cores.

Mechanical Testing Laboratory.—Tensile and transverse tests. Elongation and deflection. Compression. Hardness. Impact. Bend tests. Testing small pieces. Tests at elevated temperatures. Wear and corrosion tests.

Physical Laboratory.—Physical properties, thermal, electrical, magnetic, etc.

Foundry.—Fluidity and chill tests. Expansion and contraction. Soundness.

Engineering Drawing. — Sketching. Drawing. Reading a drawing. Casting design.

"Ni-Tensyl" in the Service of the Engineer*

In view of the outstanding properties of "Ni-Tensyl"† it is not surprising that it has already been adopted by engineers for a wide variety of high-duty castings, and there is no doubt that its fields of application will rapidly broaden as it becomes better known. The object of this Paper is to suggest to engineers and designers some of the directions in which this modern high-duty cast iron may be of assistance and interest to them.

Physical Properties

"Ni-Tensyl" is suitable for castings of all types, whatever the section thickness or design. With suitable foundry practice, the castings are remarkably sound and possess a uniformly fine grain which enables an excellent finish to be obtained on machined surfaces. A special characteristic of "Ni-Tensyl" is its remarkable uniformity; it shows little variation in structure and properties over wide ranges of section thickness. It is also very adaptable, metal from the same melt giving good results in small castings of relatively light section and in larger castings of massive or lumpy form.

For general engineering castings the tensile strength of "Ni-Tensyl" can be taken as 22 to 25 tons per sq. in. in, say, the 1-in. section; in larger sections this figure falls only two or three tons, and strengths as high as 23 tons having been recorded under ordinary foundry conditions in sections 9 in. thick. Accompanying this high strength are correspondingly high figures for other mechanical properties, including especially compressive strength, shear and torsional strengths and elastic modulus, the last generally being of the order of 20 to 22 million pounds per sq. in. The Brinell hardness of "Ni-Tensyl" is also relatively high, the figure being usually in the range of 240 to 280 in the metal as cast. In spite of this relatively high hardness the machinability of the metal is excellent and it is admirably suited to modern production methods. In consequence of its fine grain, good finish and high hardness, the metal possesses an excellent wearing quality. The toughness and impact resistance are also exceptional for cast iron, figures in the repeated impact test running into tens of thousands of blows as compared with some 100 or 200 for ordinary cast iron tested under the same conditions. These figures give ample evidence of the high resistance of "Ni-Tensyl" to shock. Fatigue tests on cast iron of high-duty types have recently emphasised the superiority of these materials, the fatigue ratio generally being of the order of at least 50 per cent. of the tensile strength.

Heat-Treatment

"Ni-Tensyl" responds well to heat-treatment. In the first place, where possible, stress annealing at a temperature of, say, 450 deg. C. is to be recommended and gives further improvement in toughness and strength by the elimination of all casting stress. This applies particularly in the case of complicated castings. Still further improvement can be obtained by oil-quenching from about 850 deg. C. and tempering in the range between 300 and 400 deg. C. where the castings are of a form suitable for handling in this manner. Such treatment will give tensile strengths up to 35 tons per sq. in. in small commercial castings, with a Brinell hardness range from 220 to 400, according to requirements.

Economies Afforded

From the point of view of the engineer the combination of properties presented by "Ni-Tensyl" simplifies design and opens up new fields of application for iron castings. At the same time it offers economies in production and in maintenance. Economies in power are also possible, due to the reduction in inertia and other power losses.

In view of the high mechanical strength of "Ni-Tensyl," castings of a given design can be more highly stressed than when the same part is made in ordinary cast iron. This is an advantage in many applications where it is desired to increase the power rating of a machine or otherwise to apply increased stress without making fundamental changes in design. A typical instance is found in connection with diesel engine flywheels for which cast iron has for a long time past been regarded as a very suitable material. Owing to the low strength of ordinary cast iron, however, a strict limit is imposed on the speed at which such wheels may run. "Ni-Tensyl," with its ability to withstand higher stresses, now permits the use of cast iron for wheels running at much higher speeds, and for wheels of larger diameter.

Other examples are large press dies, where a material of high strength and good wearing quality is required. When ordinary cast iron is used for the die body the high pressures which are employed necessitate the use of steel inserts at those points where stress is highest, and where abrasive wear is likely to take place. When "Ni-Tensyl" is used, however, such dies may be cast in one piece without the costly and involved process of fitting steel inserts.

For many smaller castings, including crankshafts, cams, gears, dies, and so on, the remarkable improvement possible in "Ni-Tensyl" by means of a simple heat-treatment can be utilised to the full. The presence of nickel markedly assists in the heat-treatment operation just as it does in the case of the other alloy cast irons and in steels, permitting heat-treatment to be carried out from slightly lower temperatures than in the case of the ordinary material, and, what is more important, permitting the best results to be achieved with a much milder quenching treatment than would be necessary in the case of the plain cast iron.

By heat-treating "Ni-Tensyl," strengths up to 35 tons per sq. in. or even more may be achieved, and by varying the tempering temperature the hardness may be held at a level of about 400 Brinell or reduced to a figure approaching 200, as desired. The higher hardnesses are, of course, useful in castings required to resist wear and abrasion, such as gear wheels or small cams and dies. It has been found that with suitable compositions of "Ni-Tensyl," heat-treated dies can be produced which offer a very useful life for light blanking operations, thus replacing in many cases more expensive steels and more complicated die designs.

Reduction in Weight

It is, of course, appreciated that in such cases as machine tool frames, mass is actually desirable and high-strength cast iron is not essential. There are, however, many applications in which a reduction of weight is of definite value and in these the adoption of "Ni-Tensyl," with its high strength, will enable sections to be cut by as much as 25 or 33 per cent.

Such a reduction in weight is of special value in castings for marine or other locations where the total mass involved must be reduced to a minimum. It frequently operates, for instance, in structural castings for shipment abroad, where freight charges and difficulties of transport in undeveloped country call for the minimum weight in finished products.

A very important type of casting in which the reduction of scantlings is of value is that used for pulleys, sheaves, and the larger hoist drums. In one case the finished drum, which was made of "Ni-Tensyl," weighed 400 tons. To make the same casting in plain iron would have involved an increase in weight of at least 100 tons. In operation, these drums must be started repeatedly, and on each occasion considerable power is spent in overcoming the inertia of the moving masses of metal in the drums themselves. It will at once be seen that the saving in weight of 100 tons in the drums leads to a substantial saving in power over long periods of time.

In the chemical and power industries, where heat transfer is required through the walls of vessels, "Ni-Tensyl," with its fine grain and dense structure, enables section thicknesses to be appreciably reduced, with a consequent increase in the thermal efficiency of the plant. Increased thermal efficiency also leads to lower temperatures on the outside or heating faces of the castings, and although the heat-resistance of "Ni-Tensyl" is good, its service life will be lengthened by the lower temperature.

Replacing Steel Forgings and Castings

In the past, when confronted by conditions of severe stress, engineers have often been compelled to resort to the use of steel in place of cast-iron castings. To-day, however, their choice is widened by the availability of high-duty cast irons, and steel castings have been successfully replaced by "Ni-Tensyl" in many of the applications already mentioned. For other purposes, too, "Ni-Tensyl" can be considered as an alternative to steel castings in general engineering practice, this applying particularly to mill parts where high stressing is involved.

A very interesting feature of "Ni-Tensyl" is that it possesses a high degree of fatigue-resistance. As a result castings in this alloy have in many cases successfully replaced steel forgings, an interesting example being afforded by their use in crankshafts for many types of petrol and even small diesel engines. Such parts are perhaps best used in the heat-treated condition (although this is not essential) and the high-duty iron offers in these applications special advantages, not only on account of its high fatigue-resistance but also on its relatively low sensitivity to notch effect. It is well fitted for this purpose because of its better-wearing quality, its shock-resistance, its relatively high elastic modulus and its power of damping vibrations.

Superior Wear-Resistance

In both the as-cast and the heat-treated conditions, "Ni-Tensyl" has very good wearing qualities and in this respect it is generally superior to steel castings. Established applications of "Ni-Tensyl" include small diesel engine liners, in which the combination of good heat- and corrosion-resistance resultant from the fine grain of "Ni-Tensyl" is of special value. It has proved valuable also for castings subjected to severe abrasion such as scraper blades in sugar milling and in many machine-tool castings where, without sacrificing rigidity, "Ni-Tensyl" may be used on account of its superior wearing quality.

There is little doubt that as the demands of modern engineering practice become more acute, so the need for these modern high-duty materials will be increasingly realised, and during the next few years engineers will be making ever-extending use of the modern high-duty cast irons.

IT IS ANNOUNCED by the Dominion Steel and Coal Corporation that it has signed a contract for the purchase of four Canadian subsidiary companies of the United States Steel Corporation.

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* Extracted from a communication from the Research and Development Department of the Mond Nickel Company.

† "The Production and Properties of Ni-Tensyl," Publication B 24 of the Mond Nickel Company. Abstracted in the FOUNDRY TRADE JOURNAL, January 28, 1937, p. 104.

New Alloys for the Foundry Industry

The Follsain process, which was originally described in THE FOUNDRY TRADE JOURNAL, has developed from being *inter alia*, a foundry product to being one capable of effecting economies in foundry practice. The process, it will be remembered, is essentially one of the production of alloys by alumino thermic cementation on the surfaces of normal materials of construction. We personally have seen some of its products being used in a large steel foundry in connection with the heating up of ladles and heat-treatment furnace equipment. This latter application is an example of the recent exacting demands made by many industries in regard to high temperature working conditions coupled with the presence of destructive gases and abrasive media. Thus there has been a steady movement towards the use of costly alloys, usually containing nickel, chromium, aluminium, and tungsten, and these alloys are in many cases so expensive that their use must necessarily be somewhat limited by this fact. It follows therefore that metals which meet the requirements and are available at moderate cost are of rapidly increasing interest in to-day's conditions. In the foundry industry there are many applications for metals of this class, and the products of Follsain Metals, Limited, of Wycliffe Foundry, Lutterworth, near Rugby, merit consideration in this connection.

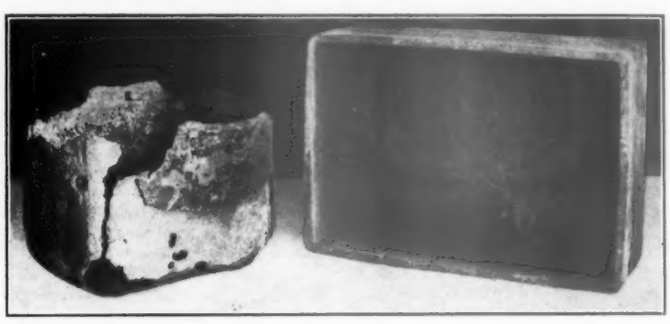

FIG. 1.—A COMPARISON BETWEEN AN ANNEALING BOX MADE FROM THE FOLLSAIN PROCESSED METAL (right) AND THE ORDINARY TYPE.

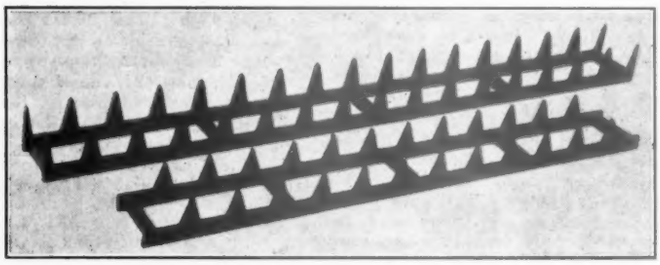

FIG. 2.—PERRITS FOR VITREOUS ENAMELLING FURNACES ARE A TYPICAL APPLICATION.

The Follsain Penetral HT Process can be applied to most classes of iron and steel, and so far as cast iron is concerned, low carbon iron is much the more suitable. Typical uses are for the treatment of recuperators as applied to furnaces of the Sesci, and Stein & Atkinson, and other rotating types; air exchangers and gas preheaters; malleable annealing pots; burner tips; pipe supports; ladle drying installations, and perrits—in fact, anywhere where ordinary steel is required to operate at temperatures of the order of 900 to 1,000 deg. C.

The Penetral HT treatment is finding a very rapidly growing field of application in connection with pyrometer sheaths, soot blowers and carburising boxes, of which many thousands are in use. This process is in all cases entirely satisfactory where the base metal is not subjected to heavy loads at high temperatures. However, it has no effect on the physical properties of the base metal; these can be preserved to the fullest extent. It follows that ordinary iron and steel treated in this way will not be suitable where heavy loads are imposed at high temperatures.

To meet this requirement the Follsain Company has developed a new alloy of the nickel-chrome type, which possesses a very high resistance to oxidation and relatively great strength at temperatures up to 1,175 deg. C. Although the analysis of this metal is similar to that of others available, owing to the special method of manufacture its service value is much higher than would otherwise be the case.

Its field in the foundry is not perhaps so wide as in other industries; it is, however, of great value in connection with parts for oil and pulverised fuel burners, pyrometer sheaths for higher temperatures, and annealing pans working at high temperatures. Although at first sight it would appear that the high cost compared with the ordinary cast-iron annealing pans would not be justified, experience has shown very clearly that a very material economy results from the use of pans made of this metal, which, as they retain their shape and their sharp edges, are easier to pack and to lute, and therefore yield a more regular product.

The company also produces "CY Metal" for resistance to abrasion. It is a cast metal containing chromium, but heat-treated by special methods, which makes it of outstanding value where heavy abrasive wear has to be resisted. It is fluid in the mould and can be cast into relatively intricate shapes; its tensile strength is about 30 to 33 tons per sq. in. It has, however, only a relatively low elongation and is therefore not particularly suitable where there is heavy shock. It is essentially an abrasion resister and in that connection is giving outstanding results for such applications as shute and ball mill liners, shunting locomotive brake blocks, coke benches, elevator buckets and links, and crushing rolls. It has been used with conspicuous success in the rolls for sand mills and pulverised fuel mills, points which of course are of particular interest to the foundry industry.

Progress of Aluminium

By "ONLOOKER."

Aluminium has come to the front very much since this century began, but the last two or three years have seen an extraordinarily rapid advance in the fortunes of this metal, which has come to be recognised as one of the world's most important materials. By itself aluminium may leave much to be desired, but as the principal constituent of strong alloys which are at the same time essentially light, it renders a service which no other metal can fulfil. The tremendous development in aviation during and since the war has created an ever growing call for light alloys for constructional purposes, and at the present moment when the British Air Force is being expanded rapidly, and the commercial side of flying is also growing out of all knowledge, an unprecedented demand for aluminium has arisen. That this will continue for some time to come cannot be doubted, and the producers must find it difficult to provide adequate supplies.

Nobody, however, appears to be short of aluminium at present, in this country at any rate, but the probability is that manufacturers are not carrying much stock. That need not worry them much provided that they cannot see themselves stopping for want of metal. The probability is that the Government has taken steps to secure a reserve tonnage of aluminium just as it is surmised similar action was taken in regard to the other non-ferrous metals earlier in the year, but, of course, the extent of the tonnage involved must be guesswork. It is not, of course, only in Britain that the call for aluminium is heavy, for other countries are pressing forward with ambitious programmes in the air and are buying accordingly. Great credit is due to the producers for their longsighted price policy, which has aimed at stability rather than at taking advantage of a situation in which an almost overwhelming demand has made it possible to lift the quotation. There is no future market in aluminium as in copper and tin, and the speculator therefore does not get a chance to take advantage of a difficult situation by competing against the consumer. Over a period of years there has been a certain amount of fluctuation in the quotation, but everybody concerned with the metal has been able to count upon comparative stability.

In the early months of this year, when other non-ferrous metals were soaring up to exceptionally high levels, it seemed that the fate of the aluminium quotation was in the balance, and there were persistent reports that an advance was imminent, but those in charge of the fortunes of this metal were shrewd enough to appraise the worth of the rise in the non-ferrous quartet on the Metal Exchange and the price remained at £100. They are now reaping their reward, for as everybody knows the speculative bubble was pricked and a sensational collapse followed, throughout which period of storm and trouble aluminium remained unaffected and stable in value. In conclusion attention may be drawn to the statistical side of the picture and a contrast of present-day production made with that of a few years ago. For 1936 the world production of aluminium was about 357,000 tons, which compared with just under 140,000 tons in 1933 and 156,000 tons in 1934. A huge increase indeed, and it is not at all unlikely that 1937 will surpass last year's figure. Examined sectionally we find that between 1934 and 1936 America trebled her output, which had, it is true, fallen a good deal, while during the same period Germany's production increased from 35,000 tons to 94,000 tons. The U.K. production last year was 16,200 tons.

Relation of Properties of Cast Iron to Thickness of Castings*

By H. L. CAMPBELL

The physical properties of the metal in grey iron castings are affected to a greater extent by differences in section than those of other cast metals. In heavy sections, which cool slowly in the mould, the strengths are less than in light sections which cool more rapidly. This situation is caused by differences in the proportion and condition of the graphite in the metal. Slow cooling promotes the separation of graphite and results in a decrease in the tensile strength of the metal.

An investigation has been made to determine the extent of the variations in the physical properties of different classes of cast iron with changes in the sections as cast. The plan for this investigation was to supplement the results of previous studies so as to cover all sections of cast iron from ¼ in. to 4 in. in thickness.

The results of a large number of tests of cast iron of different compositions in sections of 0.875, 1.20, and 2.00 in. are given in the

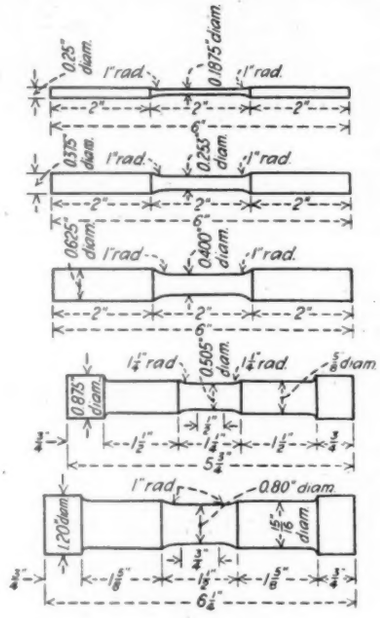

FIG. 1.—TENSILE TEST-BARS.

1934 Report of the A.S.T.M. Committee A-3 on Cast Iron.[1] Boegehold made tests of specimens cast separately in rectangular sections from ¼ to 1¼ in. in thickness after machining two sides of the cast bars.[2]

Healey obtained data on the tensile strength of the metal in a rectangular hollow casting having wall thicknesses of ¼, 1, 2, and 4 in.,[3] which showed that an average increase in strength of the metal in the ¼-in section was 11 per cent. over that in the 4-in. section. Apparently, the heat in the heavier sections retarded the cooling of the metal in the lighter sections.

Mochel determined the tensile strengths of the metal in a cylindrical casting having sections of ¼, ⅜, 1, 1¼, 2, 3, and 4 in. in thickness.[4] The tensile strengths decreased rapidly in the sections from ¼ to 1 in. in thickness, and more slowly in changing from the 1-in. to the 4-in. section. The average increase in strength of the metal in the ¼-in. section was 42 per cent. over that in the 4-in. section.

Bornstein has reported the results of tension tests of cast iron of five different compositions in separately cast test-bars having diameters of 0.75, 1.2, 2.0 and 3.0.[5] Gilligan and Curran in tests on iron castings up to 10½ in. in thickness found that the tensile strengths decreased very slowly when the sections of metal are larger than 4 in. in thickness.[6] MacKenzie's data on separately cast bars of different irons in sizes of 0.875 to 3 in. in diameter[7] show a considerable drop in the tensile strength of each iron as the section increases.

Rother and Mazurie found that the tensile strength decreased as much as 53 per cent. when the cast section was increased from 1 to 3 in.[8] Bolton's data show a considerable falling off in strength as the size of the cast bars increases.[9] MacPherran likewise reported a falling off in tensile strength with increase in sections of three types of iron.[10]

To supplement the results of tests reported previously by Committees A-3 on separately cast bars,[11] the present series of cylindrical test-bars, 15 in. in length, having diameters of 0.25, 0.375, 0.625, 0.875 and 1.20 in., were cast of irons of different compositions. The dimensions of the tensile test specimens prepared from the cylindrical bars are shown in Fig. 1. The moulds for this series of test-bars were prepared from an oil-sand mixture rammed in boxes made of 10-in. pipe. A pouring basin formed in a dry-sand core was placed on each mould, which was poured with the test-bars in a vertical position. The compositions of the nine heats used are given in Table I.

TABLE I.—*Chemical Compositions of Heats of Cast Iron.*

Heat No.	T.C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.
1	3.52	2.47	0.58	0.06	0.41
2	3.50	2.58	0.59	0.07	0.44
3	3.53	2.71	0.60	0.06	0.36
4	3.26	2.62	0.64	0.06	0.32
5	3.55	2.74	0.66	0.07	0.40
6	3.43	2.61	0.60	0.07	0.38
7	3.45	1.93	0.44	0.14	0.61
8	3.55	2.06	0.52	0.13	0.47
9*	3.30	2.46	0.90	0.10	0.18

* This heat also contained 0.50 per cent. copper and 0.30 per cent. chromium.

Special care was required in turning and testing the small cast-iron specimens. All specimens were turned from the centres of the cast bars and were tested in grips which ensured central alignment of the loads. The average tensile strengths are given in Table II. A few specimens contained defects which necessitated the exclusion of the test results from the series.

The average results of the tension tests of the separately cast bars in sizes from 0.25 to 1.20 in. in diameter from the present series of tests, as given in Table II, and on larger sizes as reported previously, are plotted in Fig. 2. The three standard sizes of test-bars recommended in the A.S.T.M. Standard Specifications for Grey-Iron Castings (A 48-36)[11] are shown. Each curve represents a different composition of cast iron. The curves are the approximate boundaries of the seven classes of iron specified in A.S.T.M. Specifications A 48. For example,

TABLE II.—*Average Tensile Strengths of Separately Cast Bars.*

Dia. of bars as cast. Ins.	Tensile Strength. Tons per sq. in. 0.25	0.375	0.625	0.865	1.20
Heat No.					
1	23.14	17.02	14.37	11.65	10.41
2	19.56	15.53	15.59	13.06	10.60
3	—	18.42	14.82	12.16	10.32
4	20.67	16.14	14.34	11.61	9.68
5	22.74	14.80	12.86	11.65	9.69
6	19.92	—	15.72	14.15	12.14
7	28.01	19.20	19.64	17.50	15.81
8	25.45	19.64	19.01	16.16	14.33
9	—	23.93	19.82	17.41	15.49

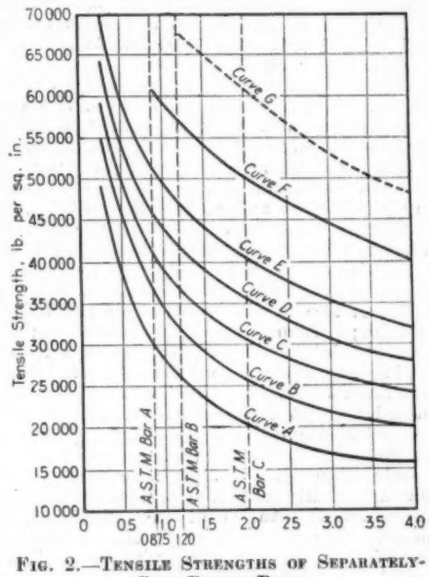

FIG. 2.—TENSILE STRENGTHS OF SEPARATELY-CAST ROUND BARS.

the area between curves A and B prescribes the range of tensile strengths of all class 20 irons, which class includes those irons having tensile strengths between 20,000 and 25,000 lbs. per sq. in. when cast in round bars 2.00 in. in diameter and tested in specimens 1.25 in. in diameter.

The variations in the tensile strengths with thickness indicated by any curve in Fig. 2 may be considered as the maximum to be expected. With greater mass of metal in a casting, even though the thickness remains the same, the cooling rate will be decreased and the tensile strengths will be less. In iron castings having sections of different sizes, the strength of the metal in any section will approach the strength of the metal in the next larger section to which it is connected, due to the heat in the heavier sections retarding the cooling of the metal in the lighter sections. Therefore, the slope of the curve showing the relation of tensile strength to thickness of an iron will be less when the cooling of any section is retarded by a greater mass of metal or by the heat from adjoining sections.

(*Concluded on page* 102)

* A Paper presented to the Fortieth Annual Meeting of the American Society for Testing Materials. The author is Metallurgical Engineer to the American Hoist and Derrick Company, St. Paul, Minn.

1 Proceedings, Am. Soc. Testing Mats., Vol. 34, Part I, p. 145 (1934).

2 A. L. Boegehold, "Effect of Section on Physical Properties of Cast Iron" Proceedings, Am. Soc. Testing Mats., Vol. 30, p. 199 (1930).

M. V. Healey, "Comparison of the Physical Properties of Different Sections of Cast Iron and of the Standard Arbitration Test Bar," Proceedings, Am. Soc. Testing Mats., Vol. 30, p. 206 (1930).

4 N. L. Mochel, Discussion of "Symposium on Cast Iron," Proceedings, Am. Soc. Testing Mats., Vol. 29, pp. 145–151 (1929).

5 Hyman Bornstein, "A Comparison of Various Sizes of Test Bars Representing Cast Iron from Five Foundries," Proceedings, Am. Soc. Testing Mats., Vol. 31, p. 152 (1931).

6 F. P. Gilligan and J. J. Curran, "Effect of Section on Tensile Strength of Grey Iron," "The Iron Age," May 19, 1932, pp. 1106–1107.

7 J. T. MacKenzie, American Cast Iron Pipe Company, private communication.

8 W. H. Rother and V. Mazurie, "The Strength of Cast Iron in Relation to Its Thickness," Transactions, Am. Foundrymen's Assn., Vol. 34, pp. 746–765 (1926).

9 J. W. Bolton, "On Research Problems of the Grey Iron Foundry," Transactions, Am. Foundrymen's Assn., Vol. 36, pp. 469–512 (1928).

10 R. S. MacPherran, "Effect of Section and Various Compositions on Physical Properties of Cast Iron," Proceedings, Am. Soc. Testing Mats., Vol. 29, Part II, p. 76 (1929).

11 1936 Book of A.S.T.M. Standards, Part I, p. 457.

Newton's Third Law of Motion

Newton's Third Law of Motion, "action and reaction are equal and opposite in direction," is very glibly recited by youths leaving school and entering industry, but except in rare cases the youth has no conception of the application of the law to objects in practical experience. Often, men of some experience believe that the law only applies to the action of one object upon another, and do not conceive that the law applies within the material of the object itself, especially in ties or struts—where the particles of the material act and react upon one another.

With youths just having left school, the author often takes the simple example of a tug of war between two opposing teams, each team at the end of the rope balancing the other with a pull of 300 lbs. When asked what the action and reaction in the middle of the rope are, the answer generally given is 600 lbs., and sometimes nothing, thus showing a mistaken conception of the law and no knowledge of the transmission of forces through a loaded object.

The posts of a small shed used as a works garage were tied in pairs at the top by wooden battens, the batten and two posts being merely nailed together. A foreman told his men to store planks of timber over the battens, and the lack of conception that a mere nail would fail to give the necessary reaction to hold up a load of timber was disastrous.

The statement that the strength of a chain is that of its weakest link gives only a vague impression unless one is acquainted with the transmission of loads from link to link, or the action and reaction of the links upon one another. If several spring balances are coupled in series—end to end—on a horizontal table, and a pull of two pounds applied at one end, the other end being secured, there is usually a misconception of the load on each balance until the youth has read the pull on each. He usually forms an idea that the pull on the first balance is 2 lbs.; that on the second balance 4 lbs.; that on the third balance 6 lbs.; and so on. The setting up of simple experiments, carried out by students themselves, appears to be necessary in order to get a clear idea of Newton's Third Law of Mechanics so as to apply it practically to the transmission of loads.

Only when the practical associations of the law are clearly conceived will one appreciate the processes involved in the building of an object. One should clearly realise that about one-third of the volume occupied by sand in a mould is actually open and filled with air, and that the runner and mould cavity into which the metal is run is also full of air. When the metal is poured, all this air becomes very hot, expands and sets up a pressure much higher than normal. Besides this hot air, other gases are produced and increase the pressure. This acting pressure meets the reaction (1) of the mould and (2) the hot metal of the casting. Should the sand of the mould not be vented sufficiently to allow the gases to permeate to the outside, the mould would form a greater reaction than the metal of the casting, and consequently the gases would be forced back into the molten metal of casting and form blow-holes, etc.

The acting pressure of the metal on cores is often rather large, and unless the reaction of the core—without crushing—is sufficient to meet the acting pressure, a spoiled casting is the result. A moulder should appreciate the stiffening of cores, upon realising that the core must provide a reaction to any pressure produced by the solidifying metal.

Only when one can secure a uniform reaction to the action of the air blast over a horizontal section of the cupola, will one obtain a uniform temperature over the section. Furnaces of any kind—when loaded—should have a uniform reaction to the air blast to have an approximate uniform temperature throughout.

In solid materials, what is called the "strength" of them can be understood only when it is conceived that it is the greatest possible reaction the particles of the material can supply to an acting load. The qualitative idea of stress in materials is better understood when it is conceived to be the reaction of the particles to the acting force. The conception of what is meant by "stress" in a material is a reality only when it is perceived that the action of the load is transmitted from one end of a link to the other by the intermediate action and reaction of the particles of the material upon one another.

Russian Research Activities

A conference has recently been held in the Soviet Union on the need to reorganise designing and research work in ferrous metallurgy. The conference, which was attended by directors of scientific research institutes, designing bodies and editors of scientific metallurgical journals, adopted a number of resolutions of far-reaching importance. The first subject to be discussed was research, and it was decided that all works with an annual output of 300,000 tons and more of rolled metal, in addition to their existing shop laboratories, should institute central works laboratories, the functions of which would include not only research in problems of immediate interest to the plant in question, but also in prospective problems. This would relieve the scientific research institutes of the need to concentrate on narrow specific subjects of interest to a particular plant and set them free to concentrate on more general subjects. At the same time, it was decided that the Central Administration of the Metallurgical Industry of the U.S.S.R. should give a definite lead to the research institutes under its control on the nature of the subjects it is desired they should concentrate on. For a more authoritative solution of various urgent problems in theory and design, the conference agreed to appeal to the Academy of Sciences of the U.S.S.R. to take a more active part in working out scientific problems relating to ferrous metallurgy.

As a result of the conference decisions, a radical reconstruction will be carried out in the work of designing. The three existing designing bodies, Gipromez, Stalproekt, Giprostal, will be merged into a single institute under the control of the Central Administration of the Metallurgical Industry, with specialised local departments. For instance, the Leningrad department of the Institute will be responsible for the general planning and designing of entire works. The Moscow department will concentrate on the designing of open-hearth and other industrial furnaces and on the solution of thermo-technical problems. The Kharkov department will concentrate on the design of sintering works, pipe foundries and their plant, as well as on the reconstruction of works and shops in operation. In addition to directing its network of designing organisations, the new Institute will control the work of the factory technical bureaux, will keep account of the designing staff, and supply them with information and material.

A function of the Institute will be to co-ordinate designing work with the plan of capital construction and of output. In order to improve the technical level of designing work, designers are to be kept in close touch with the scientific research bodies. The reorganisation of the work of designing is to be started immediately, with a view to its completion before the end of the year.

American Notes

The Saginaw Malleable Iron division of General Motors Corporation plans to add a new building, 100 by 520 ft., to their works. This will eliminate the need for a night shift, and the present force of 1,600 employees will be retained.

* * *

New Orleans is exporting between 5,000 and 10,000 tons of scrap iron every week to Italy, Japan, Poland, Belgium, Germany, Mexico and the United Kingdom.

* * *

Machine tool builders have announced price advances of from 7 to 10 per cent. as a protective measure against rising labour and material costs. Many of the plants are now booked to capacity well into the winter months. Steel prices are above first quarter quotations, while labour costs alone have risen more than 20 per cent. above 1929 levels.

* * *

The fortieth annual meeting of the American Society for Testing Materials, attended by 2,000 delegates, considered many topics of interest to metallurgists. Mr. E. V. Lange, physicist of the Radium Chemical Company, explained improved techniques quickly to detect defects in steel up to 12 in. thick. Radium is used, and its gamma rays pass through steel and record defects on a photographic film. As a result of Government decision, most purchases of heavy materials by the army and navy departments must now pass the radium inspection test. It is pointed out that a seemingly perfect steering post of a vessel may have structural imperfection which might render the mechanism useless in an emergency. Heavy steel castings, turbines, valves and high-pressure steam pipes are typical of the materials so tested.

Another new testing machine was described by Mr. C. H. Gibbons, technical adviser of the Baldwin Southwork Corporation. The device, which is designed to reveal structural weakness of steel, includes two rotating eccentric weights which, when attached to a steel structure, cause vibrations to pass through each joint, welded or riveted, and picks out the weak points.

Relation of Properties of Cast Iron to Thickness of Castings

(*Concluded from page* 101)

Relation of Compressive Strength to Thickness of Iron Castings

Specimens machined from round separately cast test-bars were tested in compression to determine the relation of compressive strength to the thickness. All surfaces of the specimens were carefully ground, with a length of specimen three times the diameter. The specimens were tested between hardened steel blocks, the upper block having a spherical seat.

The results obtained from the tests (Table III) indicate that the compressive strength increases as the thickness of the cast section decreases at about the same rate as the increase in tensile strength for the same cast iron.

TABLE III.—*Average Compressive Strengths of Separately Cast Bars.*

Dia. of bars as cast. Ins.	Compressive Strength. Tons per sq. in.				
	0.25	0.375	0.625	0.875	1.20
Heat No.					
1	67.85	47.59	38.65	29.16	36.96
2	78.57	44.34	36.30	29.46	30.00
5	84.82	46.43	34.82	30.00	35.71

Acknowledgment

The author gratefully acknowledges the assistance obtained from faculty research funds at the University of Michigan during the collection of the test data reported in this Paper.

Sheffield Foundrymen's Views on Pig-Iron

Mr. R. C. Tucker's lecture* on the subject of pig-iron gave rise to an interesting discussion which was opened by the Branch-President (Mr. J. Roxburgh), who said the question of fracture and analysis was really a very important one and had created a great deal of controversy. He agreed with Mr. Tucker that analysis was really a major consideration. If they wanted a casting to perform a certain service, they would naturally aim at a certain composition, but the second important thing was the types of metal which they would use to incorporate in the mixture. It must always be remembered that there were hundreds of foundries in this country, and in many cases similar castings were being made, but probably every foundryman used different types of materials, and different mixtures. The condition under which the particular metals were remelted was also important. He knew from experience that cupola melting differed very considerably from one foundry to another. One founder would trust one type of cupola and one another type, so that when endeavouring to standardise this, as Mr. Tucker had suggested, there were all these points which required consideration. As an example, he considered the cupolette, of which he had quite a wide experience. The important point to remember when using, say, a small charge of 10 to 15 cwts. per hr., was that with two, three or four materials in each charge, and hand shanks were used, each ladleful was different in composition. The foundry with which he was associated used to make a repetition job at one time, and the only way they could obtain a constant analysis was by melting the iron in an air furnace, running it down, and then charging the pigs on to the cupolette. By charging a mixture of several types of iron and scrap, they invariably found that each shank differed from the previous one.

Was Mr. Tucker able to reproduce the same conditions in a cupolette as he could in a larger cupola? He ventured to suggest that he could not. The cupolette, in his opinion, was rather a difficult furnace to operate, and he was afraid that, having melted some iron under those conditions, it would be rather difficult to reproduce similar conditions in a larger cupola. He knew that many people used those very small furnaces, but obviously they used a standard mixture. Personally, he used cupolettes for feeding purposes, *i.e.*, supplying the metal for feeding the castings, and also, if he had a consignment of cold-blast iron sent in, he used to run, say, 5 cwts. down and take a chill test. Under those conditions, the cupolette was definitely of use as one received an idea as to what depth of chill the particular iron would throw after melting.

He felt that a foundry manager should be responsible for every phase of his castings. The metallurgical aspect was merely one side of foundry practice, and he contended that, particularly to-day, the foundry manager had to be not only a practical but a technical man.

Envisaging Manufacture

Mr. Tucker, in reply, said Mr. Roxburgh had adopted an entirely different point of view from the one he suggested in the Paper. He had maintained that the first time he looked at a drawing of a particular casting, supposing he had not been provided with a proper specification, he would immediately suggest an analysis for the job, but he had emphasised the point in the Paper that that was not always safe. The foundry manager had to have an outlook, not merely of chemical analysis, but one based on foundry and strength properties. He had to realise the general thickness and the individual sections of the casting, note positions where "drawing" was likely to occur, and select metal of a certain strength to withstand contraction. He had to have knowledge of the physical properties of the iron, and then, either from reading, or (what was much more important and reliable) from his own personal experience, he had to decide the type of iron he required. It was useless to build a charge for a particular job from sinking or drawing type, from white pig-iron, steel scrap, and ferro-silicon. That was satisfactory in some cases, but for ordinary castings, if they needed an iron which would not sink, it was necessary to have certain constituents in their charge, and, to ensure this, it was equally necessary to know the type of constituent before the analysis was decided. The analysis could then be used as a check on uniformity, but it was no other guide.

Mr. Roxburgh had maintained that the cupolette gave variable charges of metal, and Mr. Tucker agreed that when it was operated in a certain way every shank would be of a different composition, but he suggested that for this type of test, at any rate, they were either testing the iron by itself, in which case all the shanks would be of the same type, or, if they were melting it with steel or another constituent, the size of their charges was designed to suit the size of the shank, so that the shank would contain never more than two charges, or at least one full complete charge. By this means there was a greater possibility of obtaining uniformity. He did agree, however, that different shanks should be studied very carefully when designing a standard cupolette, and in particular when designing the size of charge and the shank to be used. Mr. Roxburgh had said he actually used the cupolette method to test his cold-blast iron, and that he had relied on the chill test given by that mould to give him the ratio of the chill test that he expected to get in his larger furnaces. In other words, he found by experience that the cupolette would give a reliable indication of the properties of his cold-blast iron, which he (the lecturer) tried to emphasise in the Paper and which could not be obtained by analysis and fracture.

Mr. Roxburgh had also maintained that the foundry manager should be responsible for his casting, and Mr. Tucker thoroughly agreed that the foundry manager should have some control over his chemist, even if he did not do the job himself. If he did the analysis himself, he was bound to do it either luckily or badly. A foundry manager to-day controlled designing, organising, labour troubles, estimating and sometimes he had to seek orders. If he was to do all those jobs, and put his metal on, have a metallurgical knowledge, keep his own records, do his own testing, then the foundry manager in a medium sized foundry could not give the attention to the job that it required, and it would have to be done by somebody else. That person should be under the control of the manager, because the manager had to decide on the type of metal required, and if he was not careful, he would involve the person who was doing the metallurgical side of it in impossible situations. In all these cases a certain amount of discussion was necessary.

Mr. Roxburgh said the foundry manager had a staff whom he could consult—the patternshop foreman, the foundry foreman, the metallurgist—and he should utilise the knowledge of all these men.

Mr. Tucker agreed.

Machine-Cast Pig Eulogised

Mr. Upton, speaking with regard to machine-cast pigs, said that the time was coming when the foundrymen would not have much opportunity of saying what they would like, as they would have to accept what was offered. The speaker's experience was that those people who had used machine-cast pigs said quite definitely they would not return to the sand-cast variety.

Retention of Structure

Mr. Roxburgh said one obtained a close grained material when casting in chills, and he asked if it had been definitely proved that they regained the open structure on remelting. He remembered an old foreman who used to run his metal down into sand pigs and spray the iron with water; his idea was that, when casting a roll with this material, he could always gain two or three points of scleroscope hardness through that method, indicating that the structure was altered.

Mr. Tucker said he thought that attitude of the foreman was based entirely on his correlation of the fact that he had got a closer structure in his scrap, and he was used to raw materials coming in, such as pig-iron, which had a closer structure and gave him harder rolls. American opinion on that point was that there had been no change in the properties of engineering castings of the same analysis on the change-over, and he himself felt, on metallurgical grounds, that it would be so. A North-West Coast blast furnace and one situated near London were about the only people in this country at the moment who were making any quantity of foundry machine cast-pig, although other pig-casting machines would be coming into operation very shortly. They had made ingot moulds very successfully with it, and he believed they had found no change in the properties

The Drop Test

Mr. P. Green said the history of the materials used played a very important part in deciding upon what mixtures to use. Mr. J. E. Hurst had explained this very successfully. The "rule-of-thumb" man definitely based his mixtures upon some form of physical test, which was generally testing the pig-iron by breaking it with a sledge hammer and observing the fracture and toughness. In connection with these physical properties and the chemical analysis, he asked if any importance was to be attached to the presence of gas and the rarer elements.

A strength testing machine which was valuable in the foundry was the 25-lb. drop testing machine. In this apparatus the tup was slowly raised and dropped on to a 1.2-in. round bar. That very adequately tested the strength of the materials used. He was in agreement with Mr. Tucker regarding the small cupolette for trying out mixtures in the first stage, but he was also in agreement with Mr. Roxburgh as to the difference from one ladle to another, and that the cupolette, when used for trying mixtures, was only satisfactory when one type was put in and collected altogether in one ladle. If it was followed by exactly the same mixture in three or four charges, differences of chemical analysis were obtained in the separate ladles.

There was no doubt that machine-cast pig was very advantageous to foundries generally, as a more uniform composition was obtained, together with cheaper melting. The makers, however, had not yet tackled the question of the manufacture of low-silicon pig-irons. By the time such iron reached the foundry on the truck, and was thrown into the yard, it was reduced to about the size of peanuts. This was very difficult for charging purposes, and unquestionably was wasteful. It appeared to him that, for a very low silicon iron, some form of larger pig was required.

Large or Small Pigs?

Mr. Tucker also thought that the 25-lb. drop test was a very interesting one, but it was not standardised yet. He agreed that in the cupolette differences were obtained when different constituents were contained in the mixture, but he felt that that could be overcome by careful sizing of the raw material. For ordinary running, it was much better to run down and charge again, but for testing out raw materials by

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* Foundry Trade Journal, April 29, p. 347.

experiment he felt that some ratio of size of pig-iron to steel scrap might be calculated so that those materials would come out in their proper order.

With regard to the low-silicon pig, he thought Mr. Green was ill-advised to prefer large pigs, because he would find that smaller pigs were more satisfactory, as they had not to be so strongly water quenched. The machine-cast pigs were cooled down by water spray as they travelled up a conveyor; with a large pig, in order to get them cold enough to tip into a truck, water had to be sprayed at high pressure, but small pigs were chilled quickly and annealed on going up the last third of the conveyor, and would not fly as readily.

One firm found that, by operating their machine in a certain way, the pigs flew, yet by altering the speed of the belt and the amount of the quenching water, they were able to reduce the water quenching for the top third of the conveyor, leaving a small annealing time, and that annealing was sufficient to stop the pig-iron from flying in the truck. He thought that if Mr. Green, and others who were buying machine-cast pig, brought the matter to the notice of the makers, they would find that the difficulty could be overcome in a simple manner, either by making smaller pigs or by slowing up the speed of the pig-casting machine, and reducing the amount of quenching water.

The Newer Pig-Irons

MR. J. B. ALLAN said that so far he had not had an opportunity of trying machine-cast pig, and was therefore unable to speak authoritatively. Machine-made pig was, however, making headway, and doubtless this country would attain the same production ratio as the United States, where, he believed, something like 80 or 90 per cent. of all the pig made was machine cast.

Waterlogged Ores

MR. F. WHITEHOUSE asked what was the effect of a waterlogged ore, and what effect had the running of a blast furnace for the production of gas and slag on the pig-iron.

MR. TUCKER said a waterlogged ore had not the slightest effect on the properties of pig-iron. For example, the time the ore was in the furnace was at least 12 hrs., and the temperature at the top of the furnace, using a waterlogged ore, would be 100 deg. C., 90 ft. down, 300 deg. C., and at 40 ft. all but the big lumps of ore were therefore completely dry; and at the top of the bosh, when the ore had been broken up by carbon deposition in the interstices, due to the deposition of carbon from the gas, the largest lumps were broken up, even with massive Lincolnshire unsized ores. In furnaces which had had to be stopped and dug out, it had been found that the ore was in a definitely fine state of division high up in the stack. He thought he had shown that at the top of the bosh the pig-iron had no individuality, as it was a finely divided iron carbon alloy in a solid state, so that all that happened was that with waterlogged ore the top temperature was reduced, and therefore a lower limit was placed on the blast temperature. If the blast temperature was raised the top gas temperature was reduced, due to the closing up of the temperature zones by the increased speed of chemical reactions of the extra hot blast iron, so that all the hot zones were lowered when the blast temperature was increased, and therefore, because a lower high limit was placed on the blast temperature, then, logically, the pig-iron was not such a hot-blast iron as it might be.

No blast furnace could be run primarily for gas and slag for producers were too dependent upon their raw materials, and it was these that decided the amount of slag they used. In order to get a slag which would be useful and saleable as a road material, which was one of the main outlets for blast-furnace slag, one had to limit

(*Concluded in next column.*)

(*Concluded from previous column.*)

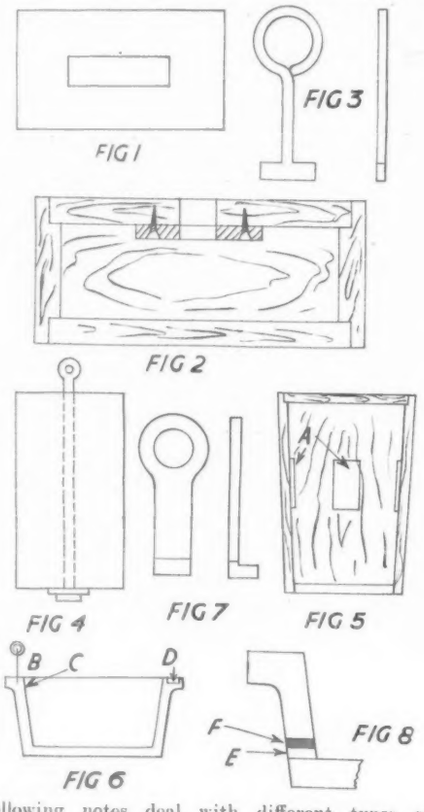
the basicity of the slag to a certain figure. Therefore, one had to place a limit on the sulphur content of the iron, which was perhaps 0.01 per cent. higher than would be the case if the furnace was run for pig-iron alone. In the latter case the sulphur content would probably be about 0.02 per cent. in a foundry pig-iron. When they were running a blast furnace to keep the slag from falling to powder when it cooled down, then the iron would run at 0.03 per cent. to probably 0.035 per cent. sulphur. In his opinion this did not affect the castings or the iron, for in his own experience anything up to 0.05 per cent. sulphur could always be neutralised with manganese.

Mr. Tucker was thanked for his lecture, on the motion of MR. C. D. POLLARD, seconded by MR. F. E. STEEL.

Lifting Plates

BY H. R. THOMAS.

The provision of adequate means of lifting the pattern out of the mould is often overlooked by a large number of patternmakers, and many patterns are supplied to the foundry without this refinement. Consequently the moulder has to use methods for pattern withdrawal which are far from ideal. The expense incurred in repairing patterns which have become damaged through the omission of suitable plates is far greater than the cost of fitting patterns with a proper means for withdrawal originally. The



following notes deal with different types of appliances for various jobs.

Fig. 1 shows a plate that is suitable for securing to the underside of a "boxed up" job, such as is shown in Fig. 2, and is used in conjunction with the key shown in Fig. 3, which is inserted in the slot and given half-a-turn. While this method is suitable for shallow work it is not always advisable on deep jobs, as the interfacial friction between the sand and pattern may cause a heavy strain to be placed on the top plate, which consequently may separate from the main pattern. For a deep job it is better to let the key pass down through the pattern and pull against the bottom, as in Fig. 4. On a deep pattern it may be advisable to make the top plate loose so that it may be withdrawn and the remainder of the pattern loosened by rapping on the plates provided on each of the four sides as at A, Fig. 5. The pattern may then be withdrawn by one or more keys extending through the bottom.

The withdrawal of bedplate, gear case and similar shell patterns usually presents some difficulties if no provision be made. Fig. 6 illustrates a section through such a pattern which in the absence of any other means is withdrawn by the moulder inserting a "lifting screw" in a number of places, such as B. This invariably results in the woodwork being damaged at C. A better method would be to insert a suitable iron plate at D with a tapped hole for the reception of a screwed eye. Although this method preserves the woodwork, it is not ideal, for the strain is taken by the wood screws securing the plate to the pattern, and invariably the plate is pulled out. A better plan is to lift from the bottom by eyes with a bent foot, as Fig. 7. When building the pattern and before the top plate is secured in position a number of slots, such as E, Fig. 8, just wide enough to take the eye, Fig. 7, are cut out and iron plates F fitted. Withdrawal of the pattern is accomplished by inserting the eyes at the various places in Fig. 8, and as all the pull assists in withdrawing the plates, the pattern is preserved from mutilation, such as occurs when indifferent methods of withdrawal are provided.

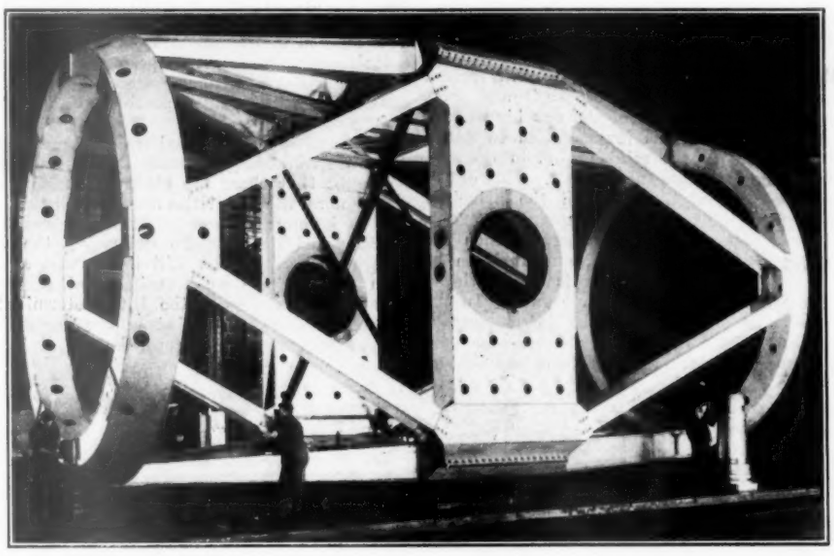
Discussion on Lubrication and Lubricants

The Council of the Institution of Mechanical Engineers, with the co-operation of 29 British and 19 overseas societies and institutions, are to hold a general discussion on lubrication and lubricants from October 13 to October 15, when a series of some 140 Papers will be presented. An endeavour will be made to establish a correlation between theory and practice, and to show how bearing design can be applied; to relate academic research with trade practice; to obtain current views upon bearing metals, and to review the significance of laboratory tests. An exhibition, which will be held at the Science Museum, South Kensington, to illustrate the subjects under discussion, will be open for a fortnight from October 13. Amongst those well known in the foundry industry who are contributing Papers are the following:—Mr. D. J. Macnaughtan (Tin Research and Development Council): "Some Factors that Influence the Service Life of Tin Base Bearing Metals"; Mr. D. P. C. Neave (Copper Development Association): "Application of Copper Alloys as Bearing Materials"; Mr. W. A. Stanier (London Midland & Scottish Railway): "Lubrication as Applied to Locomotive Journals"; Prof. H. W. Swift (Sheffield University): "Theory and Experiment Applied to Journal Bearing Design"; Mr. J. G. Pearce (British Cast Iron Research Association): "Wear of Cylinder Liners and Piston Rings for Internal Combustion and Steam Engines"; Mr. H. J. Young (Sheepbridge Stokes Centrifugal Castings Company): "Wear of Cylinders and Piston Rings"; Dr. H. W. Brownsdon (I.C.I. Metals, Limited): "Some Observations on the Effect of a Number of Added Substances on the Lubricating Properties of Oils." To render practicable adequate discussion of the Papers within the limited time available, a short summary will be prepared of all the Papers in each Group as follows:—For Group I: (Journals and Thrust Bearings) Prof. H. W. Swift, D.Sc., M.A. For Group II: (Engine Lubrication) Mr. Harry Ricardo, F.R.S., and Mr. W. A. Stanier. For Group III: (Industrial Application) Lt.-Col. S. J. M. Auld, O.B.E., M.C., and Mr. E. A. Evans. For Group IV: (Properties and Testing) Dr. H. J. Gough, M.B.E., F.R.S. The complete proceedings will be issued as a bound volume, and advance copies of the Papers will be available for use at the meetings. Further information may be obtained from the secretary, The Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.

A Large Telescope Mounting

Below we illustrate a mounting for the 200-in. telescope, the largest in the world, which will be installed on Mount Palomar, in California. Oil bearings were used as the friction of the conventional roller bearings would be 600 times greater than with an oil float. The mounting was manufactured in the South Philadelphia Works of the Westinghouse Electric and Manufacturing Company who installed a special annealing furnace, since the largest existing furnaces were not of sufficient capacity to handle the equipment which is heat-treated. The new furnace is approximately 26 ft. sq. by 20 ft. high.

The mounting was transported in the South Philadelphia shops on special low-hung wagons, and although the foundry is one of the tallest industrial buildings in the world, the tracks leading into it had to be lowered five feet in order that the telescope mounting parts could clear the doorway. The contract was awarded to the firm on January 25, 1936, and the job was completed on July 1 and then shipped by boat to Mount Palomar. It was impossible to transport it by rail because of bridge and tunnel clearances, and curves.



Mounting for the 200-in. Telescope to be installed at Mount Palomar, California.

Electrodeposition of Tin

Although acid baths for electrodeposition of tin are attractive because of their high efficiency, and the fact that they can be worked at room temperature, they suffer from the disadvantage that they are unstable solutions, and the deposits tend to be patchy and in loosely-adherent needles. To some extent addition agents enable these drawbacks to be overcome. Further research has been carried out on behalf of the International Tin Research and Development Council, 378, Strand, London, W.C.2, which has just published the results in Technical Publication Series A, Number 56.

In this Paper A. W. Hothersall and W. N. Bradshaw show that additions of sulphonic acids such as those of cresol, phenol or benzene, are ineffective when the acids are pure. Crude qualities, however, contain certain by-products of sulphonation which enable smooth deposits to be obtained especially when gelatin is present, but the solutions deteriorate rapidly and have poor covering power. Hydroxy compounds of the aromatic hydrocarbons, such as β-naphthol and

(*Concluded in next column.*)

resorcinol are most effective, and they can be used with gelatin or the more stable lysalbic acid which is prepared from egg albumen. A solution was found which had good covering and throwing power and was substantially unimpaired after long use.

Strainers for Oil

By our Engineering Correspondent.

It is well known that for efficient results with the oil firing of most types of furnace setting, as well as for forced lubrication systems, strainers must be installed in the circuit to remove every trace of solid impurity. Many makes of gauze filter, however, even of the duplex variety, have a number of inherent disadvantages, including wedging of the solid material in the gauze, and consequent tendency to collapse because of the pressure developed, and the length of the time required for cleaning.

Considerable interest attaches in this connection to the latest design of "Clinsol" oil strainer, a production of J. Samuel White & Company, Limited, Cowes (I. of W.), which is an advanced type of multiple plate or "edge" strainer, including an ingenious and efficient cleaning device with easy discharge of the separated impurities. Essentially the arrangement consists of a small vertical closed cast iron or gunmetal cylindrical body, having a flanged inlet and outlet bolted into the oil supply pipe line, operating either under suction or pressure, and formed at the bottom portion into a cleaning sump, with discharge door.

Inside the body, filling a considerable part of the space, is fixed a pack of horizontal circular thin steel plates, fixed very close together within a range of say 0.005 to 0.02 in. space, attached to a vertical spindle projecting from the top through a bearing and resting on a foot inside, fixed above the sump portion.

The space between the circular plates is adjusted as required, say according to the nature of the oil and the impurities and the degree of filtration required, by the insertion of packing pieces.

The oil enters by the inlet opening and travels horizontally through all the extremely narrow spaces between the plates, which prevent the passage of solid particles whilst offering no obstacle to the thin layers or films of oil, which emerge in the clean condition at the discharge opening. An important point, especially in comparison with the gauze filter is the great strength of the design, the standard strainer being able to withstand a pressure difference over the pack of as high as 60 lbs. per sq. in., although incidentally it is never economic nor good practice to work with such high pressure differences.

For cleaning there is fixed in the cylinder a permanent installation of stationary thin steel knives, each projecting into a corresponding aperture between the plates through the face of the pack, which latter is caused to make a partial revolution, forwards and then backwards again, by operation of a handle at the top of the spindle so as to force out all the impurities.

For easy discharge of the latter the circular plates are all constructed with a small portion cut out, which forms in the side of the pack a vertical deep channel, into which the dislodged impurities pass. This channel leads to the sump below from which the material can be taken out at convenient intervals through a cleaning door,

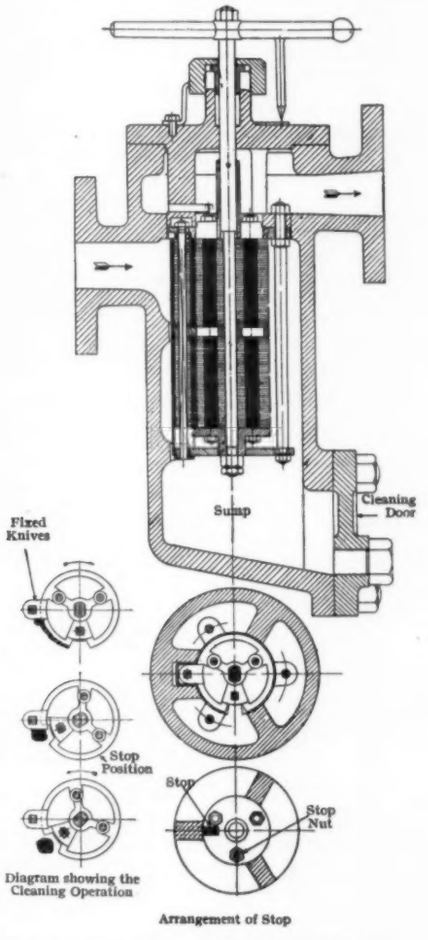


Fig. 1.—Vertical and Horizontal Sections of the "Clinsol" Oil Strainer.

provided with screwed studs or nuts. The arrangement is such also, by the use of special small pieces between the plates, that no oil can flow to the vertical discharge channel.

These standard strainers are available in a range of sizes, suitable for internal oil pipe diameters from ¾ in. to 4½ in., with a capacity of 820 to 28,000 lbs. of oil fuel per hour under discharge conditions and a distance of 0.01 in. between the plates, whilst for lubricating oil the duty varies according to the viscosity and the impurities present.

When operating under suction conditions the duties are about 33 per cent. less. Several slightly modified designs are also supplied for ½- to ½-in. pipes, one of which is intended for petrol and paraffin, while it is sometimes possible to fit a "Clinsol" pack in the body of a gauze filter.

Effect of Soluble Salts Formed during Ageing on the Scumming of Enamels*

By R. J. WHITESELL

Introduction

In wet process enamels, certain portions of the frit are soluble in the mill liquor, these soluble materials having many important effects upon the enamels. The work of Danielson[1] showed that the solubility of frits varies over a wide range, depending upon their compositions. This same work proved that the solubility of a frit varies with differences in milling conditions, and indicated specifically the variations in the Na_2O and B_2O_3 content of mill liquors from enamels ground in small laboratory mills and those ground in large plant mills. Cook[2] reported that the solubility of frits was increased with increased fineness of grinding, with agitation of the milled enamel, and with ageing.

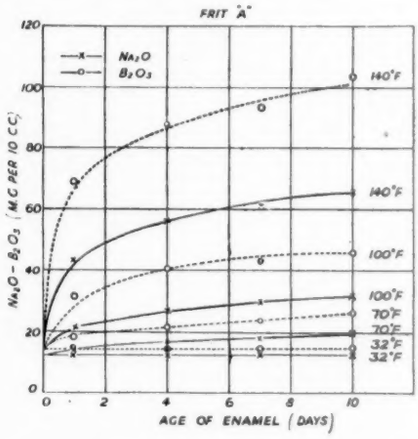


FIG. 1.—EFFECT OF TIME AND TEMPERATURE OF AGEING OF ENAMEL ON Na_2O AND B_2O_3 CONTENT OF MILL LIQUORS.

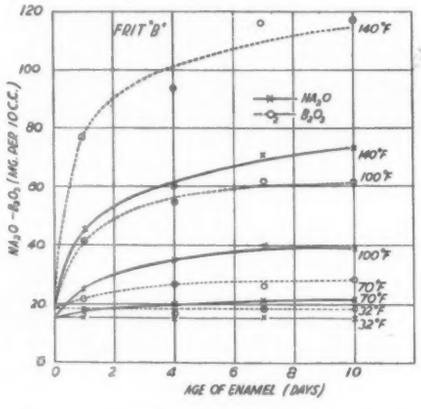


FIG. 2.—EFFECT OF TIME AND TEMPERATURE OF AGEING OF ENAMEL ON Na_2O AND B_2O_3 CONTENT OF MILL LIQUORS.

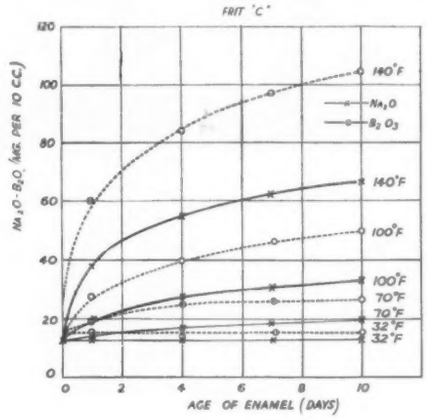


FIG. 3.—EFFECT OF TIME AND TEMPERATURE OF AGEING OF ENAMEL ON Na_2O AND B_2O_3 CONTENT OF MILL LIQUORS.

The investigations of Danielson, Cook, and Cooke[3] have demonstrated that the soluble salts in mill liquors can have very important effects on the properties of porcelain enamels. Pitting has been caused by the crystallisation of borax on the surface of the enamel during drying. These crystals burn out during firing. An excess of boric oxide has been shown to cause tearing and crawling. An increase of soluble salts may have either a beneficial or a deleterious effect upon the set of the enamel.

The quantities of these soluble salts, which are predominantly compounds of Na_2O and B_2O_3, are small when compared with the quantity of frit from which they are leached. However, during the drying of the enamel, most of these salts are carried to the surface and deposited by the evaporation of the water. This action greatly increases the ratio of Na_2O and B_2O_3 to enamel on the surface of the dry bisque. It was the purpose of this investigation to determine the effect of the soluble salts in the mill liquor on the scumming of enamels. This defect is sometimes called dulling, and the principal cause is firing at too low a temperature. This condition is often found in furnaces which are being operated at peak loads, and it is to be understood that this scumming is differentiated from that type caused by sulphur gases. In the underfire type of scumming, the defect appears on portions of the ware which are in the coldest parts of the furnace. An excellent example of this trouble was found in a plant firing refrigerator parts in a continuous furnace. Production requirements were very heavy, with a resulting low temperature in the firing zone, and the bottom parts of doors and liners were covered with scum.

Experimental

For the purpose of this investigation, three sheet steel cover coat frits were selected which it was believed were most typical of present-day enamels. These frits are designated as A, B and C, and were ground with 6 per cent. Vallendar clay, 5 per cent. tin oxide, and 42 per cent. water in 1,000-gram laboratory mills, to a fineness of 5 grams on a 200-mesh screen from a 100 gram sample of wet enamel. To ensure a uniformity of water content, the specific gravity of each enamel was adjusted to 1.80. It was desired to have enamels which were fresh milled and aged for 1, 4, 7 and 10 days at different temperatures on the day when firing trials were made. For this purpose, enamels were milled at the proper times and stored in air-tight glass containers at temperatures of 32 deg., 70 deg., 100 deg. and 140 deg. Fah.

Determination of Soluble Salts

On the day when firing trials were made, a portion of each sample of enamel was filtered, using a Buchner vacuum filter. By using reasonable care, perfectly clear filtrates were secured. This method was found to be much quicker than centrifuging, and more practical under the experimental conditions, than allowing the enamels to settle and pipetting the sample of mill liquor.

Total alkalis, calculated as Na_2O and B_2O_3 were determined by titration. While there is no doubt that there are other materials in the mill liquors, the quantities are so small that they can be ignored without affecting the results to any marked degree. To determine the Na_2O content, 10 cc. of the mill liquor was titrated with hydrochloric acid, using methyl orange as an indicator. For the B_2O_3 determination, phenolphthalein was added to the sample used in the Na_2O determination, the CO_2 taken off under vacuum, 40 cc. of neutral glycerine added to form the more highly dissociated boric acid samples, and the titration made with NaOH. At the conclusion of the alkali titration, a small excess of acid was added to aid in the removal of CO_2. The equivalent amount of NaOH was subtracted from the boric acid titration. The boric acid end-point is rather poor, but with a little practice, consistent results were obtained.

As a complete check on the results obtained above, a second series of trials was made. In the first series of trials, it is seen that there is possibility of error due to differences in milling of the various lots of enamel. In the second series, a quantity of each enamel was milled and samples of these lots of enamels were aged for the various times and temperatures as given above. Na_2O and B_2O_3 determinations were made on all samples. A comparison of the results showed that there were only slight differences in the two series. The average of the Na_2O, B_2O_3 and Na_2O: B_2O_3 ratio determinations

* A Paper read before the American Ceramic Society. The author is on the staff of Rohn & Haas Company, Inc.

1 R. R. Danielson. "Effects of Soluble Salts on the Properties of Enamel," Journal American Ceramic Society, 12, 538 (1929).

2 H. L. Cook. "Note on Solubility of Enamel Frit in Mill Water," Journal American Ceramic Society, 10, 339 (1927).

3 R. D. Cooke. "A Study of Soluble Salts in Enamel," Journal American Ceramic Society, 13, 658 (1930).

from the two series are shown in Table I, the Na_2O and B_2O_3 being reported as milligrams per 10 cc. of mill liquor. Figs, 1, 2 and 3 show these results in a graphical form.

Scumming Trials

From the first series of trials, 17 samples of each frit, 6 in. by 4 in. ground-coated plates of 20-gauge steel, were sprayed at 45 grms. per sq. ft. The plates which were used were all of the same weight, ± 1 per cent., the weight being held within these limits to prevent error, since heavier steel causes an increase of scumming. Care was taken that all plates were sprayed and dried in exactly the same manner. After drying, these plates were burned at a temperature sufficiently low so that the edges of the plates showed typical underfire scumming. Every precaution was taken to ensure that all plates received the same burning treatment.

TABLE I.—*Na_2O and B_2O_3 in Mill Liquor (Mg. per 10 cc.).*

		Frit "A."				Frit "B."				Frit "C."			
Temperature of ageing, deg. Fah.		32	70	100	140	32	70	100	140	32	70	100	140
Fresh milled	Na_2O ..	—	12.3	—	—	—	15.7	—	—	—	12.9	—	—
	B_2O_3 ..	—	14.5	—	—	—	19.2	—	—	—	15.5	—	—
	Na_2O/B_2O_3	—	0.85	—	—	—	0.82	—	—	—	0.83	—	—
Aged 1 day	Na_2O ..	13.0	14.6	21.6	43.3	15.0	16.7	25.1	46.2	13.4	14.1	19.8	38.5
	B_2O_3 ..	15.0	19.3	29.1	67.1	17.1	21.2	41.0	77.1	16.1	18.7	27.7	60.1
	Na_2O/B_2O_3	0.87	0.76	0.74	0.65	0.88	0.79	0.61	0.60	0.83	0.75	0.71	0.64
Aged 4 days	Na_2O ..	12.5	17.3	27.3	56.8	14.1	19.9	35.4	59.8	12.1	17.2	26.9	54.1
	B_2O_3 ..	14.5	21.9	41.0	87.9	16.8	27.0	54.8	93.4	14.2	25.6	40.1	84.1
	Na_2O/B_2O_3	0.86	0.79	0.67	0.65	0.84	0.74	0.65	0.64	0.85	0.67	0.67	0.64
Aged 7 days	Na_2O ..	12.9	18.4	30.1	61.1	15.5	21.1	39.7	69.7	13.3	18.8	30.3	62.4
	B_2O_3 ..	15.2	24.2	43.3	94.1	18.6	26.8	61.3	116.1	16.6	25.8	46.7	98.1
	Na_2O/B_2O_3	0.85	0.76	0.69	0.65	0.83	0.79	0.65	0.60	0.80	0.73	0.65	0.64
Aged 10 days	Na_2O ..	12.7	20.0	32.1	66.8	15.5	21.3	39.2	74.0	13.4	19.7	33.8	67.1
	B_2O_3 ..	14.8	26.2	46.6	102.6	18.7	27.9	60.9	117.4	16.7	26.7	50.4	105.20
	Na_2O/B_2O_3	0.86	0.76	0.69	0.65	0.83	0.76	0.64	0.63	0.80	0.77	0.67	0.64

RESULTS

Soluble Salts

The results of the Na_2O and B_2O_3 determinations disclose many interesting facts about the solubility of frits. With the exception that frit B is somewhat more soluble than either frit A or frit C, the results for all these frits are, in general, the same. At the end of the milling period, the mill liquors contain Na_2O and B_2O_3 in a ratio of roughly 0.80 to 0.85. When the enamel is aged at 32 deg. Fah., there is practically no solution of the frit, and the $Na_2O:B_2O_3$ ratio remains constant. However, with an increased temperature of ageing, there is a decided solution of the frit, the dissolved B_2O_3 increasing more than the Na_2O, with a corresponding decrease of the $Na_2O:B_2O_3$ ratio, until at 140 deg. Fah. the ratio is roughly 0.60 to 0.65. It will be noticed that for a given temperature of ageing, the $Na_2O:B_2O_3$ ratio remains constant, regardless of the age of the enamel. For any given temperature of ageing, there is a saturation point for the soluble portions of the frit. The fact that temperature of ageing is a much more important factor in the solubility of frits than the time of ageing, is shown on all three graphs. With frit C, for example, there is a greater solution of Na_2O and B_2O_3 in one day at 140 deg. Fah. than there is in ten days at 100 deg. Fah.; likewise, a greater solution in one day at 100 deg. Fah. than in ten days at 70 deg. Fah.

Scumming Trials

All trials with the three frits proved that the soluble salts in the mill liquor do have a decided fluxing action on the enamel. It was found that as the soluble salt content of the liquors increased, there was a decided decrease in scumming. It is to be remembered that while the actual amount of these salts is low, there is a high concentration of them on the surface of the enamel.

In all cases, the fresh milled enamel had the greatest amount of scum. Enamels aged at 32 deg. Fah. showed the same scumming tendency as the fresh enamel. With an increase of soluble salts, there was a decided decrease in the scumming, the reduction in scumming being proportional to the amount of soluble salts in the mill liquor. Referring again to Fig. 3 for frit C, the enamel aged one day at 140 deg. Fah. scums less and has a higher $Na_2O:B_2O_3$ content than the enamel aged ten days at 100 deg. Fah. Likewise, the enamel aged ten days at 70 deg. Fah. scums more and has a lower $Na_2O:B_2O_3$ content than the enamel aged one day at 100 deg. Fah.

While an increase of soluble salts has a beneficial action on the scumming of enamels, it was also noted that there were several harmful effects. With all enamels aged at 100 deg. Fah. or 140 deg. Fah., there was considerable tearing. this defect increasing rapidly with an increasing soluble salt content. In those enamels with high soluble salts, tearing was extremely bad. Another harmful action of the soluble salts is their effect on the dry bisque. Those enamels aged at 100 deg. Fah. and 140 deg. Fah. dried to an exceedingly hard and brittle bisque, which, with the highest soluble salt content, was impossible to brush. This formation of a hard, brittle bisque aggravated the tearing trouble along brushed edges.

Conclusions

(1) The solubility of typical commercial frits is influenced more by the temperature of ageing of the enamel than by the time of ageing, the rate of solution being negligible at 32 deg. Fah. and increasing greatly with increased temperatures.

(2) An increase of the soluble salts in the mill liquor produced by ageing at a given temperature or by an increase in the temperature of ageing, decreases the scumming of an enamel caused by firing at too low temperatures. While the tendency of an enamel to scum is, no doubt, affected to as great or greater degree by such factors as fineness of grinding, amount of clay, and temperature of firing, under a given set of milling and firing conditions, the soluble salt content of the mill liquor does have a very appreciable effect on the scumming. Under normal milling and ageing conditions, this change is small; however, temperatures of 100 deg. Fah. are common in enamel plants during the summer, and temperatures of 140 deg. Fah. and higher are often reached in mills which run hot. With these increased temperatures, a high soluble salt content will be built up in a relatively short period of time, and the degree of scumming will be greatly decreased.

(3) An increase of soluble salts in the mill liquor increases the tendency of an enamel to tear, and as a result of the formation of hard and brittle bisque, aggravates the tearing in places where the enamel is brushed.

The Millroom and Millroom Practice at Triplex Foundry, Limited

A large proportion of the output of stoves and grates manufactured by Triplex Foundry, Limited, of Tipton, Staffs, is finished with vitreous enamelled front surfaces. The enamelling operation involves a preliminary annealing followed by shot-blasting in the case of cast-iron components, and a "grease-burning" followed by pickling in sulphuric acid in the case of sheet steel. After these treatments, the enamel is sprayed on to the component in the form of a water emulsion, which is subsequently dried-off and fired.

Enamel for supplying the spraying booths is made up in and issued from the millroom. Various types of frit, containing oxides as colouring agents, and clay and magnesia, all of which constitute essential ingredients in the finished emulsion, are stored on a gallery which extends along two sides of the room.

The composition of the enamel is very critical, and for this reason the range of weighing apparatus required is large, and includes a small platform type machine, an ordinary beam scale for smaller quantities, and a precision balance for dealing with very small amounts of certain addition agents.

As delivered, the condition of the ingredients varies from coarse agglomerated particles in the case of the frit to relatively fine powders in the case of the colouring materials. In order to obtain a stable uniform emulsion the ingredients must be reduced to a fine state of subdivision. This operation is carried out in pebble mills.

Construction of Pebble Mills

The millroom is provided with six pebble mills manufactured by Steele & Cowlishaw, of Stoke-on-Trent. They are mounted in such a way that access to the charging aperture is obtained through traps in the gallery floor. The mills which are shown in Fig. 1 are electrically driven, the power required to run each mill being approximately 2 h.p., with a starting load about 50 per cent. above this figure. The units consist of heavy cast-iron cylinders of 2 to 3 ft. diameter and 1 ft. 9 in. to 3 ft. long, lined with porcelain blocks about 2 in. thick arranged so that no continuous circumferential joint occurs. The total weight of the largest unit exclusive of the charge of pebbles is approximately 2,660 lbs.

Pebbles constitute the grinding medium and occupy roughly 45 per cent. of the total internal volume of the mill. The largest size requires the use of 650 lbs. of pebbles of 1½ to 1¾ in. diameter. The Danish pebbles employed are smooth flints of a regular shape, and free from surface imperfection in which particles of the charge might tend to accumulate or which might initiate chipping. For grinding special or experimental batches, a small double-unit porcelain pot mill is used.

Milling the Charge

The largest mill will deal with a charge of some 200 to 300 lbs., of which 30 to 40 per cent. by volume will consist of water. Composition will vary widely, both as regards the amount of water added and the proportions of the various solid ingredients present, according to the pur-

pose for which the enamel is to be used. Thus different mixings are required for sheet steel and for cast iron due to the different thermal expansions and firing temperatures of these two materials.

Operating speeds vary somewhat both according to the particular charge being ground and according to the weight of the charge, but will in general lie below 30 revolutions per minute. Grinding times will be affected by the same factors. The completion of the milling process is indicated by the presence of a predetermined number of particles remaining on a 150-mesh sieve when a given volume of emulsion is run through; the charge is then emptied and filtered.

FIG. 1.—MILLS AT THE TRIPLEX FOUNDRY.

Filtering the Milled Enamel

Filtering is carried out on a Rotospray filter. This machine consists of a container made of fine mesh gauze attached to the spindle of a vertical high-speed electric motor. The enamel is poured in to the container whilst the latter is rotating; the bulk of the emulsion added is forced through the gauze by centrifugal force and is collected below; course particles of frit and other material remain trapped.

After filtering, the enamel is allowed to age for a certain time before it is used. Some settling out usually occurs during this period, but may be remedied by stirring, after which the enamel is in a very suitable condition for charging the spray guns. Enamel trapped in the exhaust system attached to the spraying booths is recovered and returned to the millroom for working up into a usable form.

The writer wishes to thank the Directors of Triplex Foundry, Limited, for permitting him to visit the works, and for the courtesy extended to him during his inspection of the plant.

Adhesion of Enamel to Steel Produced by the Electro-Deposition of Molybdenum Hydroxide on the Steel*

By C. R. AMBERG, H. D. PRIOR and J. C. RICHMOND

Introduction

In recent years the problem of adhesion of enamels to steel has received a great deal of attention. In spite of the extremely large amount of research expended on the subject the exact explanation of adherence is still debatable. The three theories which have received the greatest acceptance are, briefly, the dendrite theory, the oxide coating theory, and the plating-out theory. Each have their points of excellence, but the fact that more than one theory exists indicates the uncertainty present in all.

Effect of Molybdates in the Frit

On the assumption that plating out of cobalt caused adherence, it was decided to do some work on other metals than cobalt, nickel and manganese. It is well known that metallic cobalt does tend to plate out of the molten enamel under certain circumstances, and that a preliminary electro-plating of cobalt on the steel will produce adherence. A suitable metal should have at least some of the properties of cobalt. It should be in such a position in the electromotive series that iron will replace it in solution; it should be capable of assuming more than one state of valence; it should have a melting point above the ordinary enamelling temperatures; and it should not produce coloured enamels. Molybdenum seemed to possess these qualifications. However, when sodium or ammonium molybdates were substituted for the ordinary adhesion agents in a ground coat, no indication of satisfactory adherence was found, but the colour of the enamel remained white.

Plating from Ammonium Molybdate Solution

It was then decided to try electro-plating of the molybdenum. When ammonium molybdate solution was used and the steel made the cathode of a low voltage current, a black coating on the steel was formed. This coating adhered fairly firmly when wet, but could be brushed off after drying, much as dried enamel can be brushed. Upon analysis the coating was found to be $Mo(OH)_3$ or $Mo_2O_3.3H_2O$ rather than metallic molybdenum. The most satisfactory coatings for enamelling were secured when a 3 in. by 4 in. specimen of steel was plated for six minutes in a 10 per cent. ammonium molybdate solution to which 10 per cent. by volume of concentrated ammonium hydroxide had been added. The best voltage under these conditions was three volts and the cathode to anode distance one inch.

When a ground coat lacking the customary adhesion agents was applied over the dried molybdenum hydroxide coating it adhered firmly to the steel. There is no accepted way of expressing adhesion quantitatively, but a bending test is most commonly used. Tested in this fashion the adhesion would probably be rated at not quite as good as that for the same enamel containing cobalt and applied directly to the steel. The cracking of the enamel during the bending was not as finely spaced as for the cobalt enamel, but the enamel showed no tendency to flake off and leave clean steel exposed.

TABLE I.—*Composition of Enamel Tested.*

Composition of enamel.	No. 1. Cobalt enamel.	No. 2. Experimental enamel.
Borax	30	30
Felspar	30	30
Flint	22	22
Cryolite	3	3
Fluorspar	3	3
Soda ash	8	8
Zinc oxide	2	2
Manganese dioxide ..	1.5	—
Cobalt oxide	0.5	—
	Mill addition 6 per cent. Vallendar clay.	

Opacity and Blistering

Enamel No. 2 (Table I) was not opaque, with the result that the enamel appeared fairly dark because of the dissolved iron oxide in the layer in contact with the metal. With the addition of opacifier in the mill trouble from blistering was encountered. This was true for both tin oxide and zirconium oxide. Opacifying with antimony oxide in the frit or with tin oxide in the frit lessened but did not eliminate the defect. The best results were obtained with Meltopax in the frit, but even in this case occasional blisters were encountered. The difficulty of blistering has not been entirely conquered, but it would seem not insuperable since with the opacifier introduced in the frit none of the compositions showed blistering on every piece. No tendency to reboil was encountered, and as a result blisters in the first coat could frequently be covered with a second coat.

With 6 to 10 per cent. total opacifier a fairly satisfactory one coat white is possible with the exception of the blistering defect. Two coatings of enamel produced a still better white, as was to be expected.

Cause of Adhesion

With the discussion as to cause of adhesion, one enters questionable territory. In the opinion of the authors, it is believed that the $Mo(OH)_3$ coating acts as a control in the development of the oxide layer on the iron. Though the work was started under one assumption, the plating theory, results were obtained which seem to indicate the probability that the oxide theory more nearly explains the facts.

* A Paper read before the American Ceramic Society.

When molybdenum hydroxide is heated in air it readily oxidises to the yellowish molybdenum trioxide. On continued heating the trioxide melts, the melting point being 795 deg. C. It is believed that the preliminary oxidation of the $Mo(OH)_3$ prevents some oxygen from reaching the iron at lower temperatures, allows some oxidation of the iron at intermediate temperatures, and stops further oxidation when the trioxide melts. The molten trioxide is very fluid, and doubtless wets the steel surface under the enamel, thus effectively sealing it from further contact with oxygen at temperatures just a little under those at which the enamel becomes sufficiently fluid to take over the task of further protection from oxidation. If this be true the $Mo(OH)_3$ acts as an agent to control the thickness of oxide formed on the steel. It is recognised that the oxide layer is necessary for even cobalt enamels do not adhere when fired in neutral or reducing conditions throughout the burn. If the oxide layer becomes too thick the enamel is incapable of completely dissolving the layer and wetting the steel. There then remains a mechanically weak porous layer of iron oxide between the enamel and the steel. This, it is believed, causes the lack of adherence. Wetting of the steel by the enamel, it would seem, is one of the essential causes of the adherence. The intermediate layer of iron-rich glass between the enamel proper and the steel seems also essential, possibly by its causing a gradual change in the coefficient of expansion between the enamel and the steel and possibly because it so changes the properties of the enamel that it more effectively wets the steel.

The work of N. G. Martin on "Oxidation Control in Firing Ground Coat Enamels"* seems to support this explanation. He finds that firing enamels in an oxidising atmosphere up to 590 to 645 deg. C. and then finishing the fire in a neutral atmosphere increases adherence. This method controls the thickness of the oxide layer by control of the firing conditions. The $Mo(OH)_3$ seems to give an automatic method of obtaining the same result.

Reducing Enamelling Rejects

In our last month's Vitreous Enamelling Supplement we published a Paper by Mr. J. T. Gray on "A System of Plant Operation to Reduce Enamelling Rejects." This was given before the Northern Section of The Institute of Vitreous Enamellers, and the discussion which followed is published below.

Baffles for Spray Booths

MR. A. CONNELLY inquired whether there was any special reason for having the baffles at the back of the spray booth in a horizontal position, and asked if a vertical position would facilitate cleaning.

MR. J. T. GRAY, in reply, said that with some types of baffles there was no advantage to be gained by placing them either vertically or horizontally, and there was no reason why the baffles should not be vertical except in the type he had shown with the corrugations. In that case the horizontal position was preferable, and had proved to be superior. There were a number of effective baffles on the market at present, and one of the earliest types used when sprayed cast-iron enamels were introduced about eleven years ago was of the vertical louvre type. Each louvre had a radius, and was set diagonally one behind the other. The baffle shown in Fig. 3 of the Paper with the corrugated louvres, he believed, was the only one with which actual tests had been made to determine the efficiency of vitreous enamel spray-booths. He was not quite sure whether the test extended over a period of one week or a fortnight, but the figures were available, and during the period 11,823 lbs. of enamel were sprayed. The ordinary practice of cleaning out the booths at the end of each shift was continued, and at the end of the test the collecting box was removed. The weight was found to be 173 lbs., therefore, only 1.463 per cent. of the enamel sprayed was drawn into the exhaust. In some exhaust systems he had known, two horses and carts were necessary to remove the enamel dust which was cleared out.

Touching-up by Fusers

MR. A. W. HIGSON referred to fusers touching up the material before firing, and asked whether it would not be economical for them to reject it and let it go back to the department concerned? Fusers had not such a delicate sense of touch as that possessed by girls.

Mention had been made of fusers unloading from the top of a truck and going downwards. In the works with which he was associated the sprayers started at the top and went down to the bottom, while the fusers started at the bottom and proceeded to the top on account of the dust which accumulated. Personally, he did not think this dust did actually occur, although Mr. Gray had stated that it did. The fusers were not permitted to do any touching-up at all, as it was not regarded as their responsibility.

MR. GRAY agreed that it was bad practice for fusers to touch up, as emphasised in his Paper, but in the case of a jobbing plant it was sometimes necessary for one little piece in a set to be touched up so that it could go through at the same time as other parts. There was the possibility that continual rejection of one small piece in a set would result in an abnormal accumulation of finished work while nothing could be sent out until the small pieces had been reprocessed. The point he had endeavoured to make was that touching up should not be necessary if sufficient thought was applied to the preceding operations. Touching up could not, perhaps, be eliminated entirely, but much marking was due to the way the work-people were forced to handle their work. While it was realised that employees had not necessarily a delicate sense of touch it was sometimes disheartening to see the way they had to manoeuvre to get the work through, and some simple adjustments, costing very little, would really pay for themselves in this respect.

Touching up in big production plants should be completely eliminated. In some large works it was a general rule for all touching up to be done by operators specially detailed for this purpose, and, of course, they became quite proficient in this work.

In regard to fusers and sprayers handling the work, Mr. Gray said he referred to fusers handling the work in double-decking loads where the frame on the charging machine was of the double-deck type. The point was that if the lower deck was loaded first, as so often happened, then there was the possibility of scale or other matter dropping on to this work when the top deck was being loaded.

Efficiency of Screen Test Queried

MR. H. BRADLEY referred to making a test by means of screening. This was a point to which he had referred at previous meetings of the Section, but which he considered had not yet been fully elucidated. He maintained that the screen test for testing the enamel for fineness was really not as efficient as it was imagined to be. It appeared to be scarcely possible for two men making a screen test of enamel to arrive at a precisely identical result. He would like Mr. Gray's opinion as to the length of time which should be allotted for washing, because he maintained that the longer the washing the less enamel there would be in the sieve at the finish. The velocity of the water going in also had a great deal to do with the amount of enamel which was left in the sieve at the finish of the operation.

THE AUTHOR, replying, said Mr. Bradley's point was a very interesting one to which he had devoted a considerable amount of attention. Personally, he agreed that the screen test generally adopted—the 50 mls. beaker, 150-mesh sieve, and graduated test-tube—could not be considered scientific or absolutely accurate, but it gave results which were near enough for all general enamelling practice. He had always maintained that where the screen test was used then a weight test of the enamel should also be used. It was necessary to have the enamel at a predetermined weight per pint before making the screen test.

In the case of standard cast-iron enamels where the weight was 37 ozs. per pint, this should be checked before taking the screen test, and these two tests working together enabled a very close control to be maintained. It was obvious that if there was an excessive quantity of water in the enamel then there were bound to be less solid particles in the 50 mls. beaker. Regarding the time taken for running the water through the 150-mesh gauze, it would be agreed that if the washing through lasted long enough, there would be nothing left, as most enamels were soluble in water. The enamel in the sieve should be thoroughly washed through. Mr. Gray said he had never checked the time to within a quarter or half minute, but all that was required was thoroughly to wash the enamel in the sieve without washing away or reducing the size of the particles. The goal sought in introducing any test was some simple process which did not require the setting up of a scientific department, because in many works it would be uneconomic to employ a chemist to check up such small points. He considered the screen test was a very good one, and when grinding to, say, 4 units it should be ensured the enamel was ground to between, say, 3½ and 4 units, which could be called adequate for all practical production purposes. He could not quite bear out Mr. Bradley's statement with regard to discrepancies occurring if a number of people made tests. He had recently found that where two people took screen tests from a number of the same batches of enamel, the results obtained were identical within practical limits, in the case of a hollow-ware plant.

Aeration in Pickling

MR. H. WHITAKER inquired whether Mr. Gray had had any experience of aerating the acid tank over a lengthy period of time. Presumably the action was to agitate the acid in order to present a fresh surface to the metal, or perhaps to remove the film of hydrogen from the surface of the sheets being pickled. Would the acid require renewing at more frequent intervals?

THE AUTHOR said he could not give a definite chemical explanation of the action of aeration, but he knew it had practical advantages. In the case of one works in London where the pickling room was rather confined and the production was in excess of its capacity, the manager was advised to aerate the acid bath. This was at least five years ago, and it considerably increased the efficiency of the bath. Mr. Gray did not consider that aeration would reduce the life of the acid, as he knew of several works where this had been done for quite a long time, and if it had reduced the life of the acid, they would soon have discarded the idea.

MR. G. L. THOMPSON said in the reaction with the hydrochloric acid, a certain amount of hydrogen was evolved which reduced the iron compounds in the scale to the ferrous state. It

* "Ceramic Industries," 25, 60 (1936).

was necessary to oxidise these complex iron compounds to get them in the ferric state in which they would finally appear in the solution. It was probable that the oxygen had a definite chemical effect in assisting the solution of the scale in the acid bath, namely, in removing it.

Temperature Control

Mr. J. T. Gray, referring to a remark upon furnace control, agreed that a pyrometer could not give an accurate record of the temperature of the work or even of the whole of the furnace. All the indicator could register was the temperature of the thermocouple and a similar proviso would apply to the optical pyrometer. This would give the temperature of that portion of the furnace or work on which it was focused. The pyrometer was, however, a very necessary instrument as a check. If, for instance, the furnace was being operated at 850 deg. C. by the pyrometer, then one knew by experience that the work would be at, say, 800 deg. C. In his opinion automatic controllers did not control the vital point of the furnace, which was the damper. He had often heard the remark made that a man going round the country could save £10,000 a year by simply shutting down dampers on furnaces. The automatic controller controlled the air and the consumption of the gaseous or liquid fuel, but it seemed the damper was usually forgotten. Some of the latest types, however, had an attachment whereby the damper was controlled in the correct ratio to the fuel being consumed, but as far as he knew this had only proved really practical in the case of the town's-gas and producer-gas fired furnaces. Automatic temperature for gas-fired furnaces was a really sound practical proposition but it was not quite so efficient in its action in the case of oil-fired furnaces, and was almost out of the question with coal-fired furnaces unless efficient automatic stokers were used.

A simple method of testing the accuracy of a pyrometer was to place the thermocouple in a bath of molten common salt, and having set the cold-junction correctly, to observe the temperature when the salt froze. This occurred at 801 deg. C.

Regarding spray booths, he could not agree that the British ventilating engineers were obsolete in their ideas. He believed that some of the best brains in the world on this subject were to be found in this country. The important point in ventilating the vitreous enamel spray booth was to have a velocity of air sufficient to ensure good ventilation without carrying an excess of enamel into the exhaust system. If the velocity was increased sufficiently to enable a girl to work with her head inside the booth without getting any enamel dust in her hair, then there would bound to be an excessive amount of enamel drawn into the ducting, and such a high velocity as would create this condition was unnecessary.

Speaking again on the question of touching-up, Mr. Gray agreed that the fuser had to be the examiner, but he always emphasised that every operator in the enamelling shop should be an inspector of the work.

Mr. J. H. Gray did not consider it was essential for any touching-up to be done, not even in jobbing plants. It should be made quite clear to all concerned that, if a job was marked, it should be reprocessed, and that if any of the workpeople continued to mark the work too frequently, they should be reprimanded.

Mr. F. Murray observed that if a works was operated on the group system where everybody's earnings depended upon the work done by all the others, it would in effect make all those engaged into inspectors, as rejects would diminish the earnings of the group.

He thought that to-day all enamellers preferred the assistance of pyrometers, however variable the results they might indicate. Enamel suppliers, as well as pyrometer instrument makers, had done their best to make things easy for the enameller by cutting out the doubtful human equation, and the best fuser was the one who sought to work his fusing by sight in conjunction with the instruments provided.

Mr. Gray said he had in mind a plant which dealt with a very large tonnage of cast iron and about a quarter of a million pieces of sheet iron per week. In this plant there was a large number of furnaces, and as three shifts per day were in operation, there were three fusers and three helpers to each furnace, and it was almost impossible to rely on the eyes of such a large number of fusers. In such works they could not succeed without the use of automatic temperature controllers and time recorders, although, of course, the fusers always sighted their work before withdrawing the load from the furnace. In works of this type, in addition to various forms of temperature and other controllers, they had men doing nothing but taking viscosity tests, fineness tests, and operating other systems of control.

Touching-up

Mr. W. H. Whittle remarked that in the case of a multi-coloured sign shop it would not be practical to have a furnace man touching-up all the work because he would require so many colours. Moreover, a furnace cost roughly about 10s. an hour to run, so that the less time occupied in touching-up purposes the better.

The old type of fuser working before the days when there were pyrometers founded his judgment upon colour. One well-known enamelling expert had said that if the cobalt was reduced too much in the ground coat then the fusers would be absolutely lost, because they would not discern the colour they had been trained to observe.

Mr. Gray said he had had experience with both wool and metallic matter as baffles in enamel spray booths. These were installed by a works which was closely surrounded by residential property, but the experiment was not particularly satisfactory.

Mr. Leslie Graham thought it was unnecessary to have a pyrometer which was correct to 1 or 2 per cent. What was desirable was an instrument which would be constant, and he believed there were a number of such on the market.

He claimed that it was impossible to fire cast iron, and get a high-class finish, without automatic control, owing to the variety of shapes and thicknesses which had to be dealt with. The instrument which had been referred to by a speaker as being 50 deg. out had been in the furnace for nearly 5 years and had only just been checked.

The meeting terminated with a vote of thanks to the lecturer.

Steelworkers' Holidays and Wages

At the annual conference of branch officers of the Iron and Steel Trades Confederation at Sheffield recently, Mr. Walter Dodgson, divisional officer, presenting his annual report, said that the delegates present would know of the negotiations that had been taking place between representatives of the Engineering Employers' Federation and the Engineering and Allied Trade Unions in respect of war bonus and holidays with pay. An application had already been submitted to the Employers' Association by the divisional office, requesting that the matter of an increased war bonus, linked up with the question of holidays with pay, should receive early consideration. Mr. James Walker, M.P. for Motherwell, presenting the central office report, said the Confederation had paid particular attention from 1930 onwards to the position of the lower-paid men in the industry. It had never been tired of submitting to the employers that the lower-paid men, such as labourers and certain ancillary workers, were entitled to more substantial wages. In this the officials of the Confederation had persevered, with the result that to-day it could be said that the lower-paid workmen engaged in the iron and steel trade of this country were in receipt of better wages than had ever been the case in the history of the industry.

Sir Harold Hartley

I.V.E. PRESIDENT-ELECT

Brigadier-General Sir Harold Hartley, C.B.E., F.R.S., M.C., M.A., the Vice-President of the London Midland & Scottish Railway Company, has been nominated President of The Institute of Vitreous Enamellers. Dr. J. W. Mellor, F.R.S., who has not enjoyed good health for some time, has intimated his desire to be relieved from office. Sir Harold Hartley is amongst the most distinguished of British scientists, and before the war was Bedford lecturer in physical chemistry at Oxford. During the war he was Controller of the Chemical Warfare Department of the Ministry of Munitions. In 1930, he was elected President of the British Cast Iron Research Association. It is expected that he will preside over the fourth annual meeting of The Institute of Vitreous Enamellers to be held in Birmingham on October 8.

Sir Harold Hartley, C.B.E.

Welding Enamelled Letters

In a recent issue of our American contemporary, "Oxy-Acetylene Tips," there was an article on welding sheet metal letters for neon signs. Hitherto there has been some trouble caused by cracking, chipping and similar defects in the finish due to extremes in temperature and weather. Previous practice was to make this type of relief letter from ordinary galvanised sheet-iron stock. The joints were soldered and the letters finished by painting. Re-finishing and touching up at frequent intervals were generally necessary. The adoption of enamelling stock iron with a porcelained finish has made it possible for these sign letters to withstand weather conditions infinitely better.

By the modern method, component parts of the sign are cut out of the enamelling stock iron, fitted together, tack-welded and then all edges joined with a butt-type joint. No welding rod is necessary. The finished job gives a smooth and properly rounded joint for porcelain enamelling. As enamel adheres perfectly to the oxy-acetylene welded joints, the porcelain does not crack or chip off when hot or cold weather causes these letters to expand or contract.

IN THE INTERESTS OF THE WORKERS

Talk No. 3.

Blythe employees off for an outing

On Holidays

We look forward to our holidays, because we like to work hard and to play hard too.

So do our workpeople. To enable them to enjoy their well-earned leisure, we give them each a holiday of three weeks in the year, with full wages whilst away; in fact, we pay fifty-two weeks' wages to our workers in every year.

In between holidays we all work enthusiastically, because ours is a happy firm, and we like to be happy ourselves and to see others who are happy round us. In the evenings we play cricket, tennis, football, or enjoy our Winter social evenings.

One frequent visitor says that in such country surroundings as ours, he takes a holiday every time he comes to our works!

Why don't you take a holiday too, and come over to visit our plant and see our sports ground?

We shall be only too pleased to arrange it, because we feel that the conditions under which we work are something to be proud of, and we know that they help a good deal in maintaining the unfailing quality of our service to customers.

Blythe COLOURS

BLYTHE COLOUR WORKS LTD

CRESSWELL, STOKE-ON-TRENT

This Week's News in Brief

Trade Talk

WORKERS IN THE galvanised ware, hollow ware and drum workshops in the Hammond Lane Foundry, Dublin, have accepted an offer of wage increases, ranging from 11 to 20 per cent.

THE DYSART ROAD IRONWORKS, Grantham, which have recently been purchased by R. H. Neal & Company, Limited, of Ealing, are to be opened in the near future for the manufacture of cranes.

HEAD, WRIGHTSON & COMPANY, LIMITED, Thornaby-on-Tees, are to supply the complete equipment of the tinning section of the new strip mill which Richard Thomas & Company, Limited, are building at Ebbw Vale.

C. A. PARSONS & COMPANY, LIMITED, Heaton, Newcastle-upon-Tyne, have an order for a 50,000 kilowatt turbo-alternator for the Dunston Power Station and another of similar size for the Bunnerong Power Station, Australia.

LAST THURSDAY Col. K. C. Appleyard, O.B.E., J.P., chairman of the North Eastern Trading Estates, Limited, and a Past-President of the Newcastle Branch of the Institute of British Foundrymen, presided at a luncheon to North-East Coast industrialists which followed the ceremony of laying the foundation stone of the Central Administration Buildings on the Team Valley Estate by Sir George Gillett.

SIR W. G. ARMSTRONG WHITWORTH & COMPANY (ENGINEERS), LIMITED, have disposed of their Scotswood Works, Newcastle-upon-Tyne. Vickers-Armstrongs, Limited, announce that they are entering into an arrangement with the purchasers under which they will lease the works as from August 2, and from that date these works will be operated by Vickers-Armstrongs, Limited, as part of their Elswick establishment. Arrangements have been made between the parties for completion of the work on existing orders.

THE TOHO, NIPPON AND DAIDO POWER COMPANIES, the Tokyo Electric Light Company and the Ujigawa Electric Company of Japan may start the treatment of iron-containing sand as a joint undertaking. Considerable quantities of this sand are available. The Chuo Electric Company has been conducting an experiment with this sand at Naoetsu, Niigata Prefecture, for some time, and it is stated that about one kilowatt of current is required for the extraction of one ton, though most authorities would place this figure much higher.

J. A. CRABTREE & COMPANY, LIMITED, of Walsall, are to give works employees on clock and time check a full week's pay during the annual holiday week. This concession took effect with the August holiday period this year, and was applicable to all employees who had been in the continued service of the company for at least twelve months. All works employees who have been in the continued service of the company for five years will receive payment at ruling day rates for all national holidays and bank holidays. Upwards of 1,500 workers benefit by these regulations.

EDGAR ALLEN & COMPANY, LIMITED, Sheffield, have received orders for a No. 4 stag ball mill and ancillary crushing and elevating plant, from Capper Pass & Son, Limited, Bedminster Smelting Works, Bristol; a 10-ton electric furnace, from the Electric Furnace Company, Limited, London; a crushing and screening plant, from the Trent Navigation Company, Limited, Nottingham; two rotary dryers for a British company; a crushing plant for a Derbyshire quarry, and an auxiliary crushing plant for the Aberthaw & Bristol Channel Portland Cement Company, Limited, East Aberthaw, Rhoose, Glam.

Next A.F.A. Convention

The American Foundrymen's Association will hold its next convention and exhibition in Cleveland from May 14 to 19, 1938. The exhibition, which will occupy the public auditorium and Lakeside exhibition hall, will be opened for the benefit of local foundrymen on Saturday, May 14. The technical sessions to be held in the meeting rooms of the public auditorium group of buildings will start on May 16 and conclude with the closing of the exhibition on May 19. The central position of the city, and the prominence of Cleveland as a foundry centre, with 118 foundries making a wide diversity of all classes of castings, provide unusual facilities for works visits.

Personal

MR. T. P. N. BURNESS, works manager of Ruston & Hornsby, Limited, has been appointed a director of the company.

MR. J. L. FRANCIS, honorary secretary of the East Anglian Section of the Institute of British Foundrymen, has changed his address to 12, Glenhurst Avenue, Colchester Road, Ipswich, Suffolk.

THE MANY FRIENDS of Mr. S. G. Smith, an honorary member of the Institute of British Foundrymen, who is living in retirement at 153, Sturdee Avenue, Gillingham, Kent, will be pleased to hear that, in spite of his 75 years, he is still in good health, although his eyesight is not now too good. He would welcome any letters from members of the Lancashire Branch.

MR. J. E. O. LITTLE has been appointed chief chemist and metallurgist to Glenfield & Kennedy, Limited, in succession to Mr. F. Hudson. Previously he was assistant to Mr. T. H. Turner at the L.N.E. Railway Company's works at Doncaster for some years, and prior to that was at the Caledon Engineering & Shipbuilding Company, Limited, Dundee, in charge of Perlit iron production.

Will

DALZIEL, ROBERT, iron and steel merchant, Glasgow £2,480

Obituary

MR. PETER RAE, J.P., who died on July 26, aged 85, was for 73 years employed by the Carron Company.

MR. THOMAS ROBB, who celebrated his golden wedding last week, died a few days later at the age of 75. He had been employed at the foundry of John Bryce in Kirkcaldy for 34 years before retiring.

MR. G. H. WHITEHOUSE, founder and senior partner of George H. Whitehouse & Son, Limited, iron and brass founders, of Horseley Heath, Tipton, was killed when a Dutch air liner crashed near Brussels last week.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Leeds Smelting Works, Limited.—Capital, £11,000. Iron and brass founders, smelters, etc. Directors: R. G. Metcalfe, 10, Park Square, Leeds, and C. C. Wood.

Electric Converter Furnaces, Limited, 190, Imperial House, Regent Street, London, W.1.—Capital, £5,000. Electrical engineers, etc. Directors: T. D. Kelly and R. Blandy.

Standard Alloys, Limited, Connaught House, 63, Aldwych, London, W.C.2.—Capital, £5,000. Manufacturers and refiners of alloys, etc. Subscribers: E. Schjoth and A. L. C. Chalk.

Twilliards, Limited, 9, Clements Lane, Lombard Street, London, E.C.4.—Capital, £500. To acquire patents, licences and concessions. Ironfounders, engineers, implement and machinery manufacturers, etc. Directors: F. W. Buszard, K. S. Thompson, and J. Williams.

Clark Inventions, Limited.—Capital, £100. Manufacturers, repairers of and dealers in forgings, castings, engines, motor cars, locomotives, aircraft, etc. Directors: W. J. Clark, The Hon. Brian E. Lewis, and A. M. Geddes. Subscribers: A. G. Maby, 5, Thavies Inn, London, E.C.1, and R. J. L. Williams.

Contracts Open

Seaton Delaval, August 11.—1,600 yds. of 3-in. and 1,000 yds. of 4-in. cast-iron water mains and cast-iron specials, for the Seaton Valley Urban District Council. Mr. T. W. Burgess, Council Offices, Shiremoor, Northumberland.

Johannesburg, August 30.—16 four-ton, alternatively 15 four-ton and one 10-ton level luffing electric portal travelling wharf cranes, for the South African Railways and Harbours Administration. The Department of Overseas Trade. (Reference T.Y. 25,290/37.)

Company Meeting

W. & T. Avery, Limited

SIR J. FORTESCUE FLANNERY, BT., chairman of W. & T. Avery, Limited, in the course of his speech to shareholders at Birmingham last week, said that no money had been spared either at Soho Works or at the Parnall Bristol Works to provide workshops, machinery, and services which combined every attention to the well-being and the comfort of the operator with the pride he and the firm had in the products of those workshops. Their designing staffs continued to meet the special requirements of practically all known industries. They had found it necessary during the year to expand their sales and service staffs so as to give that attention to their customers which should continue to be satisfactory in every respect. Their associated companies in South Africa, in Australia, in New Zealand, and their branches in India had all shown progress. Referring to the future the speaker said it was easy to give one an account of what they had done, but it was never so easy to forecast what the future had in store for them. The addition of the rearmament programme to the steady revival in industry had brought fresh problems. They all knew the vital necessity of this programme, and industry was cheerfully shouldering the burdens which had been thus occasioned, but the effect of this enormous programme on prices both for labour and materials, and on supplies, was a very real feature, the extent of which it was not easy to determine. They were all anxious to avoid lifting prices to the extent that the real benefit of the increased earnings was lost, but in considering the future it should be borne in mind that not only had industry to undertake increased burdens, but that costs had a tendency to rise.

Company Reports

Hadfields, Limited.—Interim dividend on the 10s. ordinary of 9d. per share, less tax, equivalent to 7½ per cent.

Davy & United Engineering Company, Limited.—Net profit for year to March 31, £44,297; brought forward, £7,033; available, £51,330; dividend of 7½ per cent. per annum on ordinary, £27,256; carried forward, £21,859.

Armstrong Whitworth Securities Company, Limited.—Net income for year to December 31 amounted to £14,531, to which has been added the profit less losses of subsidiary companies after providing for depreciation of plant and machinery, £585, making the net income for the year £15,116. This amount has been deducted from the balance at debit of profit and loss account at December 31, 1935, of £2,934,783, thereby leaving a balance at debit at December 31, 1936, of £2,919,667.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

H.D.A. (DEVICE).—Unwrought and partly-wrought metals. High Duty Alloys, Limited, 89, Buckingham Avenue, Trading Estate, Slough, Buckinghamshire.

"NOBELOY."—Metals and metal goods. I.C.I. Metals, Limited, Imperial Chemical House, Millbank, London, S.W.1.

"DOLOFER." — Refractory bricks. Refractory Brick Company of England, Limited, Steetley, Worksop, Notts.

"BIRMAL."—Non-ferrous metals and alloys. Birmingham Aluminium Casting (1903) Company, Limited, Dartmouth Road, Smethwick, Birmingham.

The New Factory Bill

The Industrial Welfare Society has arranged a special course of three lectures to explain the far-reaching changes in factory law to be brought about by the Factories Bill which is expected to pass into law this month. The lectures will be given by Mr. H. Samuels, Barrister-at-law, at the headquarters of the Society, 14, Hobart Place, Westminster, S.W.1, from 6.30 to 7.45 p.m. on September 16, 23, and 30, the fee for the course being £1 1s. (15s. in the case of member firms).

HIGH GRADE MALLEABLE — IRON CASTINGS —

PROMPT DELIVERIES

●

BIRMINGHAM STEEL CO., LTD.,
202, FAZELEY STREET, BIRMINGHAM, 5

Telephone: VIC. 1941 (6 lines)

WARNER Special PIG IRONS

- Warner C.B.R. and Low Carbon Cylinder
  (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable
  (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

●

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

● **Typical Cylinder Pig Iron Specification**

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

● **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO. LTD.
CARGO STREET · MIDDLESBROUGH

Raw Material Markets

Optimistic views are being expressed with regard to the pig-iron position; it is hoped that increased production and heavier imports will tend to ease the shortage in the near future. Any additional basic iron which becomes available will be taken up immediately by the steelmakers. Producers hope to reduce their delivery arrears whilst many of the consuming plants are closed for essential repairs. Mr. Oliver Stanley, President of the Board of Trade, speaking at Warrington on Saturday, advised manufacturers not to neglect the export trade of the country. Sooner or later the Government orders on rearmament would come to an end, and then manufacturers would need more than ever the export trade which they might lose unless they maintained some connection during the current period of abnormal home demand.

Pig-Iron

MIDDLESBROUGH.—The holidays, and more especially the inability of makers to add to their order-books, have caused the market in this area to become somewhat quieter in appearance. It is expected that there will be extra supplies available for distribution next month. Holidays are being made as short as possible, but some idle time is inevitable, as repairs have to be carried out. For delivery in Middlesbrough and district, No. 3 G.M.B. is quoted at 101s. per ton, while deliveries to Falkirk are charged at 104s. and to Clydeside 107s. The demand for hematite remains far in excess of production. The steelworks are taking up large tonnages and there is only a comparatively small amount left for distribution to other destinations. Although financial benefits could be secured, export trade is having to be more or less neglected. East Coast mixed numbers are quoted at 122s. 6d. per ton on the North-East Coast, 128s. in Sheffield, and 133s. 6d. in the Midlands.

LANCASHIRE.—Deliveries of pig-iron have been well maintained recently. Generally speaking, consumers have adequate supplies to enable them to keep up a normal output, but there are cases where users are less fortunately placed. There is no improvement in the supply of home-produced hematite, but imports of American material are on a better scale. Offers of Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron for delivery in the Lancashire price zone are all on the basis of 109s. per ton, with Northants at 107s. 6d. and Derbyshire forge iron at from 104s. to 106s. Scottish No. 3 is quoted around 137s. 6d., West Coast hematite at 131s. and East Coast material at 130s. 6d. delivered equal to Manchester.

MIDLANDS.—The present period of comparative quietude in this area is certain to be of a temporary nature only. Nevertheless, producers are glad of the opportunity to lessen their delivery arrears to some extent. It is expected that a revival in the demand from the light-castings makers will not be long delayed. For delivery to Birmingham and Black Country stations, Northants No. 3 is quoted at 103s. 6d. per ton, with Derbyshire, Lincolnshire and North Staffordshire No. 3 at 106s. Low-phosphorus iron at from £6 10s. to £7 5s., delivered to this area, is not easy to obtain. Supplies of hematite are very short and consumers do not find it possible always to satisfy their immediate needs. Deliveries are having to be rationed very carefully. East Coast No. 3 is quoted at £6 13s. 6d., with West Coast mixed numbers at £6 14s. 6d., including delivery to Birmingham and district stations. An extra 1s. 6d. per ton is charged if delivery into works is stipulated.

SCOTLAND.—It would appear that little effect was made on delivery arrears owing to the recent Fair holidays. No. 1 foundry is quoted at 115s. 6d., and No. 3 at 113s., f.o.t. furnaces. Work at the light-castings plants is being restricted by the quantity of pig-iron available. No. 3 Cleveland iron is quoted at 104s. f.o.t. Falkirk and 107s. f.o.t. Glasgow. Imports of pig-iron have helped to relieve the position at the steelworks, but further supplies are urgently needed. Mixed numbers of hematite are quoted at 123s., British basic 107s. 6d. and Indian basic 100s., all f.o.t. steelworks and less 5s. rebate.

Coke

Conditions remain firm on the foundry-coke market. Prices are unchanged, but further advances are not unlikely in the near future. For delivery to Birmingham and district, the minimum price for Durham or Welsh coke is 50s., the better grades being quoted at up to 65s. per ton.

Steel

Quiet conditions have ruled in the steel market during the past week; it remains an exceedingly difficult proposition to transact new business, while the holidays have been taken in the producing areas this week. Users of semi-finished steel are inconvenienced by the poor supply available, but it is expected that the position will be relieved somewhat shortly by the arrival of increased imports. Finished steel consumers are anxious to negotiate for supplies as far ahead as possible, but makers are cautious about extending their commitments too far. In one or two cases producers have disposed of their outputs over the early months of next year, but, as yet, this is the exception rather than the rule.

Scrap

In a letter addressed to the Minister of Health explaining the position in respect to the collection of household scrap iron, the managing director of the British Iron and Steel Corporation states that the response to the Corporation's campaign has been tremendous. There has, however, been misunderstanding regarding prices. It was perhaps inevitable, the letter says, that many should assume that a "scarcity" price should be expected, but, strictly speaking, no famine of iron and steel scrap exists. It has been argued that steelworks could afford to pay higher prices, and thus create a greater incentive to collection. National policy, however, requires that the costs of steel production, upon which the prices of steel products are strictly based, should be kept as low as possible. The public as well as the Government are fully protected in this respect, as steel prices are subject to the approval of the Import Duties Advisory Committee following a comprehensive audit of costs. It can, therefore, be appreciated that for the person getting rid of his old iron to insist on receiving payment commensurate with the imaginary value he gives it may be to take away the livelihood of some small trader.

Steelworks' requirements of scrap generally are being more easily met, due, to a large extent, to the arrival of substantial tonnages from abroad. Nevertheless, it is still difficult to obtain additional supplies and prices are firmly maintained.

Metals

The London Metal Exchange was closed after the morning 'Change on Friday and reopened on Tuesday morning.

Copper.—There has been only a small industrial demand during the past week, but the firm tone of the market has been maintained. Active conditions continue to prevail in the United States and some good tonnages are regularly changing hands. Business on the Continent generally has been quiet.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £56 17s. 6d. to £57; Friday, £57 8s. 9d. to £57 10s.; Tuesday, £57 16s. 3d. to £57 17s. 6d.; Wednesday, £57 10s. to £57 11s. 3d.

Three Months.—Thursday, £56 16s. 3d. to £56 17s. 6d.; Friday, £57 6s. 3d. to £57 7s. 6d.; Tuesday, £57 16s. 3d. to £57 17s. 6d.; Wednesday, £57 10s. to £57 11s. 3d.

Tin.—Holiday influences continue to predominate in this market and several weeks are likely to elapse before the position again becomes normal. Buyers in the United States are only taking up such supplies as they require for immediate use. Tinplate mills in America are again working at around 100 per cent. of normal capacity.

Mr. Adolf Henggeler, local head of the Anglo-Oriental Tin undertaking, at the meeting of the Kuala Kampar tin fields, urged Malaya to give unbiassed consideration to any scheme of international reserve tin stocks, because the quota system was alone insufficient to prevent violent price fluctuations due to consumers' sudden demands. At the recent meeting of the Tin Producers' Association in London. Sir Godfrey Fell said that, in connection with the administration of the International Tin Control scheme, the Association had urged strongly the necessity for the direct representation of tin-producing interests on the signatory Governments' delegations. It was gratifying to note, he said, that the Nigerian, as well as the Malayan tin-producing interests, were now represented on the delegations which constitute the International Tin Committee, thus placing the important British producing interests in a not less favourable position than other interests. With regard to the proposal to reconstitute a buffer stock, he said, the best interests of the industry could only be achieved by giving full consideration to the interests of the consumer. They had no desire to see production fall below the requirements of the consuming industries, thus creating an actual shortage, with its commensurate sharp rise in price. This might be temporarily to the benefit of producers, but only at the expense of consumers, and, therefore, it was not, in the long run, in the best interests of the industry as a whole. He thought that the Association should express itself in favour of the creation of a reserve stock, provided that this stock was under the control of the producers and was released under some automatic system and marketed through the usual channels.

Official quotations have been as follow:—

Cash.—Thursday, £263 10s. to £263 15s.; Friday, £261 to £261 5s.; Tuesday, £262 10s. to £262 15s.; Wednesday, £262 15s. to £263 5s.

Three Months.—Thursday, £261 2s. 6d. to £261 5s.; Friday, £259 5s. to £259 7s. 6d.; Tuesday, £260 5s. to £260 7s. 6d.; Wednesday, £260 7s 6d. to £260 10s.

Spelter.—This market has been quite strong recently and the outlook is satisfactory. Following a period of heavy buying in the United States, conditions have again become quieter. Supplies of the metal are still on the short side.

Daily market prices:—

Ordinary.—Thursday, £22 12s. 6d.; Friday, £23; Tuesday, £23 6s. 3d.; Wednesday, £23 2s. 6d.

Lead.—A fair inquiry has been received during the past week and consumption has been well maintained. Demand in the United States also is active and heavy tonnages are under requisition.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £22 15s.; Friday, £22 17s. 6d.; Tuesday, £22 17s. 6d.; Wednesday, £22 10s.

Scrap.—Owing to the holidays, trade has not involved any substantial tonnages, but a resumption of business is looked for at an early date.

Approximate selling prices for old metal:—New aluminium cuttings, £82; rolled, £67; cast, £43; aluminium foil No. 1, £94 to £98. Heavy, clean copper, £56; braziery, £49; light, £51. Heavy brass, £36 to £37; light, £32. Zinc, £15. Lead, soft sheet and pipe, £22 10s. Gunmetal, £53.

Absorption of Tin Stocks

Interesting details concerning the trend of the tin market during 1936 are contained in the annual report of the Tin Producers' Association. It is stated that since the operation of the international tin restriction scheme made possible the absorption of the vast surplus stocks which had been allowed to accumulate, stocks had been maintained at between 9 per cent. and 14 per cent. of the current rate of consumption. At the end of June, 1937, world visible stocks amounted to 22,439 tons. During 1936 the price of tin did not maintain the high degree of stability which it had attained since the inception of the international tin agreement, says the report. This was due, in the early months of that year, to the uncertainty about the prospects of the renewal of the scheme. The average price of tin during 1936 was £205 per ton.

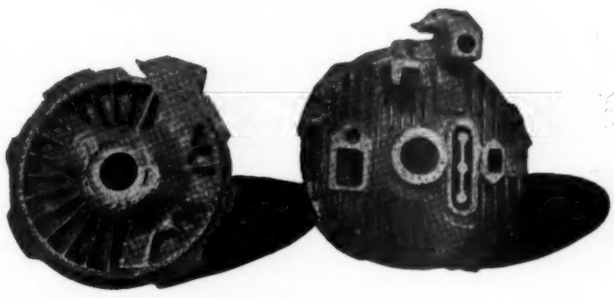
Joint Committee on Materials and Their Testing

The first technical discussion under the auspices of the Joint Committee will be held in the Large Hall of the College of Technology, Manchester, on Friday afternoon and evening, October 29, commencing at 2.30 p.m. and terminating at 7.30 p.m. approximately. The following papers on notched-bar impact testing have been promised:—(1) "The Physical Meaning of Impact Tests," by Professor R. V. Southwell, M.A., F.R.S., University of Oxford; (2) "Some Aspects of the Notched Bar Test" (in two sections, namely: a brief review of past experiments in this country and an experimental exemplification of several features of the test), by Mr. L. W. Schuster, M.A., British Engine Boiler and Electrical Insurance Company, Manchester; and (3) "The Development and Present Position of Continental Research on the Notched Bar Impact Test," by Dr. Ing. Max Moser, Messrs. Fried Krupp, Essen.

There are various grades of YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractability of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.



YORKSHIRE SAND

for "easy stripping"

Information regarding the most suitable grades of Yorkshire Sand for your particular needs and full technical details will be given without obligation.

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GENERAL REFRACTORIES LTD.,

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Genefax House, Sheffield

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Other Moulding Sands include—Zenith Red Sand, York Yellow 102 Sand, Scottish Rock Sand, Bramcote Red Sand, Harperley Sand, Hensall Sand, Red Rover Sand, Warsop Sand, Mansfield Sand.

RAW MATERIALS—PRICE LIST

(Wednesday, August 4, 1937)

COPPER

	£	s.	d.
Standard cash	57	10	0
Three months	57	10	0
Electrolytic	64	15	0
Tough	63	13	9
Best selected	64	3	9
Sheets	92	13	9
India	74	13	9
Wire bars	65	8	9
Ingot bars	65	8	9
H.C. wire rods	68	18	9
Off. av. cash, July	56	9	$4\frac{7}{11}$
Do., 3 mths., July	56	8	$2\frac{8}{11}$
Do., Sttlmnt., July	56	9	$2\frac{5}{11}$
Do., Electro, July	63	10	$2\frac{2}{11}$
Do., B.S., July	63	12	6
Do., wire bars, July	64	4	$3\frac{9}{11}$
Solid drawn tubes			$14\frac{1}{2}$d.
Brazed tubes			$14\frac{1}{2}$d.
Wire			$10\frac{1}{2}$d.

BRASS

Solid drawn tubes	$12\frac{1}{2}$d.
Brazed tubes	$14\frac{1}{2}$d.
Rods, drawn	$11\frac{1}{2}$d.
Rods, extd. or rlld.	$7\frac{1}{2}$d.
Sheets to 10 w.g.	$10\frac{1}{2}$d.
Wire	$9\frac{1}{2}$d.
Rolled metal	$9\frac{1}{2}$d.
Yellow metal rods	$7\frac{1}{2}$d.

TIN

	£	s.	d.
Standard cash	262	15	0
Three months	260	7	6
English	262	15	0
Bars	264	15	0
Straits	264	5	0
Eastern	261	0	0
Banca (nom.)		—	
Off. av. cash, July	263	14	$1\frac{1}{11}$
Do., 3 mths., July	262	6	$8\frac{8}{11}$
Do., Sttlmt., July	263	14	$2\frac{5}{11}$

SPELTER

	£	s.	d.
Ordinary	23	2	6
Remelted	21	0	0
Hard	20	0	0
Electro, 99.9	25	16	3
English	24	7	6
India	21	0	0
Zinc dust	30	0	0
Zinc ashes	7	5	0
Off. aver., July	22	12	$7\frac{4}{11}$
Aver. spot, July	22	11	$4\frac{7}{11}$

LEAD

	£	s.	d.
Soft foreign, ppt.	22	10	0
Empire (nom.)	23	15	0
English	24	10	0
Off. aver., July	23	16	$4\frac{7}{8}$
Aver. spot, July	23	18	$7\frac{7}{11}$

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.	£	s.	d.
Zinc sheets, English	36	0	0 to	36	10	0
Do., V.M. ex-whse.	36	0	0 to	36	10	0
Rods				31	10	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	82	10	0 to	83	10	0
Chinese, ex-whse.				70	0	0
Crude, c.i.f.				36	0	0

QUICKSILVER

	£	s.	d.
Quicksilver	13	10	3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£14 10 0
45/50%	£12 0 0
75%	£17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum— 70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium— 20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten— 80/85%	5/3 lb. (nom.)
Tungsten metal powder— 98/99%	5/4½ lb. (nom.)
Ferro-chrome— 2/4% car.	£34 15 0
4/6% car.	£24 5 0
6/8% car.	£24 0 0
8/10% car.	£24 0 0
Ferro-chrome— Max. 2% car.	£36 0 0
Max. 1% car.	£38 5 0
Max. 0.5% car.	£41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 lb.
Metallic chromium— 96/98%	2/5 lb.
Ferro-manganese— 76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese— 94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 7d.
Finished bars, 18% tungsten	3s. 6d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ¼ in. × ⅛ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	0 to	3	10	0
Mixed iron and steel	3	5	0 to	3	7	6
Heavy cast iron	3	8	0 to	3	10	0
Good machinery				4	0	0
Cleveland—						
Heavy steel, best	3	2	0 to	3	9	0
Steel turnings				2	15	0
Heavy cast iron				4	7	6
Heavy machinery				4	10	0
Midlands—						
Short heavy steel	3	17	6 to	4	0	0
Light cast-iron scrap				3	5	0
Heavy wrought iron	4	0	0 to	4	5	0
Steel turnings	2	2	6 to	2	5	0
Scotland—						
Heavy steel, best	3	4	6 to	3	7	0
Ordinary cast iron				4	7	6
Cast-iron borings	2	0	0 to	2	2	6
Wrot-iron piling				4	15	0
Heavy machinery	4	13	6 to	4	15	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	47	0	0
Brass	30	0	0
Lead (less usual draft)	19	10	0
Tea lead	14	0	0
Zinc	14	0	0
New aluminium cuttings	74	0	0
Braziery copper	41	0	0
Gunmetal	45	0	0
Hollow pewter	165	0	0
Shaved black pewter	120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	103/6
,, No. 3	101/-
,, No. 4	100/-
Forge No. 4	100/-
Hematite No. 1	123/-*
Hematite M/Nos.	122/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/-*
,, d/d Birm.	134/6*
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	103/-
,, No. 3 fdry.	106/-
Northants forge	100/6
,, fdry. No. 3	103/6
,, fdry. No. 1	106/6
Derbyshire forge	103/-
,, fdry. No. 3	106/-
,, fdry. No. 1	109/-
Scotland—	
Foundry, No. 1, f.o.t.	115/6
,, No. 3, f.o.t.	113/-
Cleveland No. 3, Glasgow	107/-
,, ,, Falkirk	104/-
Scottish hem. M/Nos. d/d	123/-*
Sheffield (d/d district)—	
Derby forge	100/6
,, fdry. No. 3	103/6
Lincs forge	100/6
,, fdry. No. 3	103/6
W.C. hematite	128/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	109/-
Staffs fdry. No. 3	109/-
Northants fdry. No. 3	107/6
Cleveland fdry. No. 3	109/-
Glengarnock, No. 3	137/6
Clyde, No. 3	137/6
Monkland, No. 3	137/6
Summerlee, No. 3	137/6
Eglinton, No. 3	137/6
Gartsherrie, No. 3	137/6
Shotts, No. 3	137/6

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to	13	15	0
Nut and bolt iron	11	12	6 to	12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ¼ in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				19	10	0
Galv. flat shts. (,,)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	13¼d.
Sheet to 10 w.g.	13¾d.
Wire	15½d.
Rods	15¾d.
Tubes	20½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round— to 10g.	1/6½ to 2/1½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2·40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	36/-
Durham foundry	37/-
,, furnace	35/-
Scottish foundry	37/6
,, furnace	35/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		25/- to 26/-
,,	28×20	,,	51/- to 52/-
,,	20×10	,,	36/6 to 36/9
,,	18¾×14	,,	26/3 to 26/6
C.W.	20×14	,,	22/6 to 23/-
,,	28×20	,,	46/- to 46/6
,,	20×10	,,	32/- to 32/6
,,	18¾×14	,,	23/- to 23/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	£12	0	0 to	£13	0	0
Bars-hammered, basis	£20	0	0 to	£21	0	0
Bars and nail-rods, rolled, basis	£19	0	0 to	£20	0	0
Blooms	£16	0	0 to	£17	0	0
Keg steel	£27	0	0 to	£30	0	0
Faggot steel	£20	0	0 to	£25	0	0
Bars and rods dead soft st'l	£19	0	0 to	£20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
July	29 ..	56 17 6 inc.	1/3
„	30 ..	57 8 9 „	11/3
Aug.	3 ..	57 16 3 „	7/6
„	4 ..	57 10 0 dec.	6/3

Standard Tin (cash)

		£ s. d.	
July	29 ..	263 10 0 inc.	30/-
„	30 ..	261 0 0 dec.	50/-
Aug.	3 ..	262 10 0 inc.	30/-
„	4 ..	262 15 0 „	5/-

Spelter (ordinary)

		£ s. d.	
July	29 ..	22 12 6 dec.	2/6
„	30 ..	23 0 0 inc.	7/6
Aug.	3 ..	23 6 3 „	6/3
„	4 ..	23 2 6 dec.	3/9

Lead (soft foreign, prompt)

		£ s. d.	
July	29 ..	22 15 0 inc.	1/3
„	30 ..	22 17 6 „	2/6
Aug.	3 ..	22 17 6 No change	
„	4 ..	22 10 0 dec.	7/6

Electrolytic Copper

		£ s. d.	
July	29 ..	64 0 0 No change	
„	30 ..	64 5 0 inc.	5/-
Aug.	3 ..	64 15 0 „	10/-
„	4 ..	64 15 0 No change	

Tin (English ingots)

		£ s. d.	
July	29 ..	263 10 0 inc.	20/-
„	30 ..	261 0 0 dec.	50/-
Aug.	3 ..	262 10 0 inc.	30/-
„	4 ..	262 15 0 „	5/-

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
July	29 ..	25 3 9 dec.	2/6
„	30 ..	25 10 0 inc.	6/3
Aug.	3 ..	26 0 0 „	10/-
„	4 ..	25 16 3 dec.	3/9

Lead (English)

		£ s. d.	
July	29 ..	24 15 0 inc.	5/-
„	30 ..	24 15 0 No change	
Aug.	3 ..	25 0 0 inc.	5/-
„	4 ..	24 10 0 dec.	10/-

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 2½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 6	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12	2 13	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 9½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 10 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1933	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1934	3 7 0	3 9 6	3 13 2½	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 12 11½
1935	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 18 0	3 18 0	3 14 8
1936	3 18 0	3 18 0	3 18 0	3 18 0	3 18 0	3 18 0	4 3 0	4 3 0	4 3 0	4 3 0	4 3 0	4 9 0	4 1 0
1937	4 9 0	4 9 0	4 9 0	4 9 0	4 9 0	5 9 0	—	—	—	—	—	—	—

* No prices available during strike period.

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FOR SALE.—One Bell-type Automatic Cupola Charger by Head Wrightson. 5 ft. dia. by 4 ft. deep. Unused.—HARRISON BROS. (ENGLAND), LTD., Middlesbrough.

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Two 16″ "Princeps" LITTLE SCORCHER STEAM DRYERS.
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MISCELLANEOUS

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MISCELLANEOUS—*Continued*

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